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**COACHING THE COACHES: SUPPORTING UNIVERSITY SUPERVISORS IN
THE SUPERVISION OF ELEMENTARY MATHEMATICS INSTRUCTION**

By

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B.A., University of Louisville, 1994
M.A.T., University of Louisville, 1997**

**A Dissertation Submitted to the Faculty of the
College of Education and Human Development of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of**

Doctor of Philosophy

**Department of Teaching and Learning
University of Louisville
Louisville, KY**

May 2012

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A Dissertation Approved on

April 6, 2012

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Samuel C. Stringfield

DEDICATION

To my daughters,

Raegan and Jordan

the two most important accomplishments of my life

&

To my husband,

Jamie

For encouraging me to pursue my dreams

ACKNOWLEDGEMENTS

This dissertation marks the achievement of a goal that I set for myself when I was in eighth grade. I have always known that I would pursue a PhD. Once education became my passion, I was out to save the world. I loved teaching, I loved making a difference, and I loved empowering others. I also have many individuals whom need to be acknowledged for their support, guidance, time, expertise, and love.

First, I have to start with my family. My husband, Jamie, I am eternally grateful for you running the house and taking care of our girls, while I have been dedicated to this work. Raegan and Jordan, thank you for loving me and understanding when “mommy was busy”. I have done this for you! I want you to hold true to you dreams. Thanks to my parents for instilling in me that I could be and do anything that I wanted. Dad, you convinced me early on to always give 110%. Mom and dad, your confidence and support have been amazing.

Second, Dr. Chuck Thompson helped me find my teaching voice. As my university supervisor when I was an MAT, he always pushed me to be better. Good was never good enough. Throughout my teaching career, Dr. Thompson has always been there to help, guide, and support me. I thank you for always asking those questions to make me think.

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Last, I must acknowledge those who helped me with data analysis. Thank you, Sarah Bush, Sarah Whitt, and Kristie Manley for your gifts and expertise. It truly takes "a village" to accomplish this monumental task.

I can do all this through Him who gives me strength. Philippians 4:13

ABSTRACT

COACHING THE COACHES: SUPPORTING UNIVERSITY SUPERVISORS IN THE SUPERVISION OF ELEMENTARY MATHEMATICS INSTRUCTION

Stefanie D. Livers

April 6, 2012

Teacher candidates enter teacher preparation programs with grounded beliefs about teaching and learning. These beliefs are especially problematic in the area of mathematics, as they hinder instructional decisions (Karp 1988, 1991; Kolstad & Hughes, 1994; Pajaras, 1992, Wilkins, 2002) and maintain a traditional approach for the teaching of mathematics (Beswick, 2006; Wilkins, 2002). Teacher education programs must address these beliefs in order to create a climate for change. A critical influence on teacher candidates is the university supervisor assigned to their field placement site. The supervisor provides the connection between theory and practice during the critical time prior to student teaching (Grossman et al., 2008). As accountability increases for teacher preparation institutions to prove effectiveness of their teacher candidates, all aspects of the program have to be evaluated and supported. University supervisors must be provided with the necessary professional development in order to prevent the disconnect that is possible with that role - between the philosophy of the teacher education program and the reality of the field placement

The purpose of this study was to analyze the impact of providing professional development on the topics of coaching and mathematics pedagogy on the university

supervisors' supervision practice and teacher candidates' beliefs and instructional practice. The mixed-methods program evaluation study was designed to answer the following two questions: What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of elementary teacher candidates? What are the effects of training university supervisors in mathematics education and coaching practices on elementary teacher candidates' beliefs and their instruction in mathematics?

This study required approved program changes that included requiring university supervisors to attend professional development and observe all elementary mathematics methods teacher candidates. The study used both qualitative and quantitative data to analyze the impact of the professional development. Qualitative data consisted of background information, observations, and interviews. Quantitative data included Reformed Observation Teaching Protocol (RTOP) scores and belief scores from the Mathematics Beliefs Instrument (MBI) for both the university supervisors and the teacher candidates.

Analysis of the data revealed that the supervision practice of the university supervisors changed as a result of the professional development. University supervisors added paraphrasing and mediating questions to their practice. They fostered reflection by allowing the teacher candidates to problem solve. Teacher candidates also experienced changes in their beliefs and instructional practice.

This study revealed that professional development does make a difference. By focusing on the university supervisor as part of the education of teacher candidates, the

cohesiveness of the teacher preparation program is strengthened. Additional studies are needed to validate these results and extend them into longitudinal studies.

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CHAPTER 1

INTRODUCTION

Overview

This study examined the impact and relationship of the university supervisor on teacher candidates' beliefs and teaching of mathematics in elementary classrooms. This introduction of the dissertation presents the research problem, the theoretical framework, the purpose of the study, and outlines the research questions. The significance of the study is explained. Lastly, the limitations, assumptions, and definitions of key terms are provided.

Problem Statement

Results from the 2007 Trends in International Mathematics and Science Study (TIMSS), indicated that students in the United States are well behind their international peers in mathematics (Mullis, Martin, & Foy, 2008). This is particularly frustrating in that in 1989, the National Research Council compiled twenty years of research that led to a call to action. The report identified these findings:

- Far too many students, disproportionately minority, leave school without having acquired the mathematical power necessary for productive lives.

- The shortage of qualified mathematics teachers in the United States is more serious than in any other area of education, and affects all levels from elementary school to graduate school.
- At a time when the percentage of minority students is increasing, the shortage of new minority teachers of mathematics is particularly acute.
- On average, U.S. students do not master mathematical fundamentals at a level sufficient to sustain our present technologically based society.
- When compared with other nations, U.S. students lag far behind in level of mathematical accomplishment; the resulting educational deficit reduces our ability to compete in international arenas.
- Public attitudes, which are reflected and magnified by the entertainment industry, encourage low expectations in mathematics. Only in mathematics is poor school performance socially acceptable.
- Curricula and instruction in our schools and colleges are years behind the times. They reflect neither the increased demand for higher-order thinking skills, nor the greatly expanded uses of the mathematical sciences, nor what we know about the best ways for students to learn mathematics.
- Calculators and computers have had virtually no impact on mathematics instruction in spite of their great potential to enrich, enlighten, and expand students' learning of mathematics.
- Common methods of evaluation especially standardized, paper-and-pencil, multiple-choice tests of "basic skills" are themselves obstacles to the teaching of higher-order thinking skills as well as to the use of calculators and computers.

- Undergraduate mathematics is intellectually stagnant, overgrown with stale courses that fail to stimulate the mathematical interests of today's students.
- The information age is a mathematical age. Even as tomorrow's scientist and engineer will need extensive mathematics education, tomorrow's citizen will need a very different type of mathematical education to deal with. (NRC, 1989, pp. 73-74).

This clearly painted a bleak picture that mathematics teaching and learning must undergo a major transformation. “Because mathematics is one of the pillars of education, reform of education must include significant change in the way mathematics is taught and learned” (NRC, 1989, p. 73). A new reform era began with the release of national mathematics standards (NCTM, 1989, 2000). The standards described a view of mathematics teaching and learning that emphasized conceptual understanding. Despite this reform, little has changed in classrooms across the nation. Classroom teaching of mathematics continues to resemble the traditional teaching seen 60 years ago (Beswick, 2006). In addition research reveals that elementary teachers are often not prepared to teach mathematics (Ma, 1999) and their attitudes toward mathematics have been connected to their style of teaching (Karp 1988, 1991; Kolstad & Hughes, 1994; Wilkins, 2002). Teachers with positive beliefs and attitudes toward mathematics tended to teach in a more constructivist, student-centered way, while teachers with negative beliefs and attitudes were more traditional in their methods (Wilkins, 2002). The teaching of mathematics remains an issue in improving student performance. Ineffective teaching hinders student achievement (Brophy, 1987). Effective mathematics instruction that involves teaching for understanding increases student achievement (Vinson, 2001).

Based on these trends in mathematics education, the content and design of the teacher preparation program becomes critical. The first reaction of education programs to poor mathematics performance of students was to increase the number of mathematics content courses required of teacher candidates (Carnegie Forum, 1986; Holmes 1986). However, others have found that it is by challenging teacher candidates' beliefs and attitudes within mathematics methods that makes a positive difference (Borko et. al, 1992). Research about challenging teacher candidates' beliefs and attitudes have centered on changing their teaching practices and activities within a mathematics methods course (Ball, 1989; Hart, 2002; Leonard, Newton, & Evans, 2009; Stuart & Thurlow, 2000; Swars, Daane, & Giesen, 2006; Wilkins & Brand, 2004) or in a broader sense their teaching program (Swars, Hart, Smith, Smith, & Tolar, 2007).

Practicing teachers have usually credited field work and student teaching as the experiences that they most value and that prepared them the most (Sadler & Klosterman, 2009). The field experience remains a critical component of teacher education programs (Darling-Hammond, Bransford, lePage, Hammerness, & Duffy, 2005; Goodlad, 1990; Kagan, 1992; Tang, 2004; Zeichner, 1990). Within the teacher education program, there are commonly a series of sequenced experiences and corresponding supports in place to guide and help teacher candidates grow and learn. Teacher candidates are given placements with cooperating teachers in local schools. To provide support between the university and the placement site, university supervisors provide the bridge among the research, philosophy and pedagogy of the university with the practical application of the field (Zeichner, 2002). University supervisors who typically fill the role of an instructional coach are able to provide effective support, problem solving strategies, and

engage in dialogue about instructional practices. This is especially true when the university supervisor matches the support to the developmental level of the teacher candidate (Glickman, 1980; Glickman & Gordon, 1987). This is crucial in the development of elementary mathematics teachers who need to confront their beliefs about the teaching and learning of mathematics (Smith, 2001; Stuart & Thurlow, 2000). These supervisors need to be skilled in both best practices in mathematics instruction and methods of coaching in order to provide the necessary feedback, support, and evaluation to challenge teacher candidates' beliefs and improve their instructional practice.

The attitudes and beliefs of teacher candidates have been examined extensively. Attitudes and beliefs about teaching and learning develop throughout one's life and are sometimes solidified prior to taking college courses (Kagan, 1992; Nosich, 2009; Richardson, 1996). These beliefs include what they believe to be good teachers, instructional strategies, and student learning (Kagan, 1992; Pajares, 1992; Richardson, 1996). Teacher candidates' beliefs about their education program can be classified into two categories: teaching and the teaching profession and teacher preparation program (Chong, Wong, Lang, 2005). Nosich (2009) labeled these attitudes and beliefs as "background stories" and concluded that they are almost impossible to alter. Nosich (2009) stated:

Background stories are so difficult to counteract because they are virtually invisible. We don't see them as background stories at all. We see them simply as *the way things are*. As a result, the background stories influence our interpretation of everything we encounter. We don't *hear* that the account we learn in our course contradicts our background stories. (p. 122)

Attitudes and beliefs are part of the reason why teachers tend to teach mathematics the way that they were taught (Ball, Lubienski, & Mewborn, 2001). These background stories need to be explicitly challenged and checked in order for learning to truly take place; this means that teacher candidates need to identify their attitudes and beliefs and participate in activities that challenge their belief system (Stuart & Thurlow, 2000). This puts the burden on colleges of education to identify beliefs and support teacher candidates in being open to new ideas and philosophies for education (Chong, Wong, & Lang, 2005). The risk is if these beliefs are not addressed, traditional teaching practices will remain the norm (Chong, Wong, & Lang, 2005).

The Current Study

Prior research provided knowledge about teacher candidates and the importance of the examination of their beliefs and attitudes. We know that elementary teachers are not prepared to teach mathematics and that their background beliefs and attitudes interfere with new learning. We know that the design of the mathematics methods course and the corresponding testing of these ideas in the field can provide the catalyst for change. One area about which we don't know enough is the role of the university supervisor in this process. We need to know how the relationship between the university supervisor and the teacher candidate challenges the teacher candidates' beliefs and attitudes about the teaching and learning of mathematics and supports the change process. The examination of the effect of the university supervisor's supervision and support can inform teacher education and mathematics education with regard to the importance of the university supervisor, the training and support needed for the university supervisors, and the impact of coaching on challenging teacher candidates' beliefs and attitudes about

mathematics with the intention of changing instructional practices to increase student achievement.

Theoretical Framework

The theoretical framework for this study is a combination of Fuller's (1969)'s concern theory and social constructivism (Cobb, Yackle, & Wood, 1992; Meehan, Holmes, & Tangney, 2001). These are described below.

Fuller's framework was chosen because it follows the developmental levels of teacher candidates and provides a frame of reference for the university supervisors who coach them (Glickman, 1980). Two frameworks were considered: Fuller and The Concerns-Based Adoption Model (CBAM; Hord, et al, 1987). CBAM was a possibility as it is usually linked to studies involving coaching (Hull, Balka, & Miles, 2009; Killion & Harrison, 2006; Woleck, 2010). CBAM consists of seven levels of use compared to Fuller's three stages. Due to the limitations of the study, Fuller's framework was chosen. Fuller outlined three stages through which teacher candidates typically progress as they grow and develop in his model of concern theory. These stages of concern are self, task, and impact (McCulloch & Thompson, 1981). The first concern that teacher candidates have is about them. Their concerns at this stage are likability and survival. A question that teacher candidates ask themselves in this stage is "Where do I stand?" (Fuller, 1969, p. 220).

The second stage is concern about competency, which includes their content knowledge and skills. "This larger concern involves abilities to understand subject matter, to know answers, to say "I don't know," to have the freedom to fail on occasion,

to anticipate problems, to mobilize resources, and to make changes when failures occur” (Fuller, 1969, p. 220). They worry if they can teach a subject well and are able to handle the situation.

Lastly, the teacher candidates are concerned about the impact that they have on student learning. Fuller (1969) explained:

The specific concerns we have observed are the concern about the ability to understand pupils’ capacities, to specify objectives for them, to assess their gain, to partial out one’s own contribution to pupils’ difficulties and gain and evaluate oneself in terms of pupil gain. (p. 221)

Social constructivism was chosen as a complementary framework because of the importance of the social content in which learning takes place. It also was chosen because “mathematics educators almost universally accept that learning is a constructive process” (Cobb, et al., 1992, p. 3). This perspective of social constructivism states that even within a traditional mathematics classroom constructivism occurs (Cobb, et al., 1992). Thus, in a mathematics methods course students construct their own knowledge and must learn to help students construct their own understandings. This perspective allows for the examination of the relationship between the teacher candidates’ changes in their beliefs and attitudes toward mathematics and the university supervisors’ role of coaching the teacher candidates.

Using both of these two frameworks, this study describes the stages of Fuller’s concern theory experienced by the teacher candidates in addition to the knowledge that is constructed during the supervision process in mathematics field placements.

Purpose

Scholars have provided mixed views about the role and impact of the university supervisor. University supervisors are often hired and then provided little or no training. They are expected to be the connection between theory and practice but are often not engaged in the creating or examination of theory on a regular basis. Coupled with that is the research that teacher candidates hold beliefs that hinder them from learning to teach mathematics and elementary teachers are not prepared to provide quality mathematics instruction (Ma, 1999). The purpose of this study is to examine the impact of support during mathematics instruction of elementary teacher candidates provided by university supervisors after the supervisors receive professional development in the areas of coaching and mathematics pedagogy.

Research Questions

1. What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?
2. What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?

Significance of the Study

The majority of the research on challenging teacher candidates' beliefs and attitudes about mathematics has been conducted within mathematics methods courses (Hart, 2002; Leonard, et al., 2009; Stuart & Thurlow, 2000; van der Sandt, 2007) or by

analyzing the impact of the cooperating teacher (Shandomo & Zalewski, 2008). This study is designed to add a different perspective to the literature by exploring the role of the university supervisor impacting the teacher candidate's beliefs and attitudes.

This study will provide needed information about the university supervisors' impact on teacher candidates in the area of mathematics. In particular, it will describe instructional strategies like coaching, feedback, and content specific observation tools designed to assist elementary teacher candidates of mathematics.

Delimitations

This study took place in the fall 2011 semester. The chosen place for this study was a College of Education at a mid-western, public, urban university. The sample needed for this study included the elementary university supervisors and university students (teacher candidates) enrolled in mathematics methods classes or student teaching. This sample included both undergraduate and graduate level teacher candidates.

Assumptions

This study was based on several assumptions. The first was the sample would be representative of other teacher candidates enrolled in mathematics methods courses and other university supervisors at other colleges of education. The second assumption was that the responses from participants would accurately reflect their professional practice and beliefs. The third assumption was that the participants answered all questions openly and honestly.

Definition of Terms

Attitudes: These are a person's emotional responses that contain positive or negative feelings. These responses are strong and long-lasting and develop based on repetitive emotional responses (McLeod, 1992; Pehkonen & Pietilä, 2003).

Background stories: Beliefs and attitudes that are formed and work as a filter that impedes new learning and application (Nosich, 2009).

Beliefs: These are a person's "subjective, experience-based, often implicit knowledge and emotions on some matter or state of art" (Pehkonen & Pietilä, 2003, p. 2).

Coaching: This is an act of leading someone into dialogue about the study of his/her teaching practice to facilitate reflection and application (Showers, 1985).

Cooperating teacher: Sometimes referred to as a mentor teacher. This teacher is a practicing, certified teacher that mentors teacher candidates in a classroom setting.

Field placement: This is the school where teacher candidates are assigned a cooperating teacher in which to complete course and program assignments.

Field work: These are the assignments and teaching required from courses and program requirements. This is sometimes referred to as field experience.

Mathematics methods: A teacher preparation course that focuses on the instructional strategies and pedagogy necessary to teach mathematics to children.

Pedagogical content knowledge: This is an understanding about appropriate content specific strategies and an awareness of the appropriate nature of sequencing the content

elements. This understanding is fixated on conceptual understanding of the content (Shulman, 1986).

Reflection: A process that focuses on” self-analysis, or retrospective consideration,” of one’s teaching practice (NBPTS, 2010)

Teacher candidates: Sometimes referred to as student teachers or pre-service teachers, these are teachers in training. They are students enrolled in a teacher preparation program.

University supervisors: Former teachers, principals, instructional coacher and professors who observe and evaluate elementary student teachers in the field at local schools.

Overview of the Following Chapters

In the next chapter, literature will be reviewed that establishes the foundation for this study. The reform efforts in mathematics education, the teacher candidates’ field placements, the roles, responsibilities, and impact of university supervisors, effective coaching practices, and teacher candidates’ beliefs and attitudes will be considered. In chapter three, the research design will be described in terms of sample, setting, instrumentation, timeline, and positionality. Also included in chapter three are the data collection and analysis methods, information regarding the validity and reliability of the study’s processes, and the limitations of the study’s design.

CHAPTER II

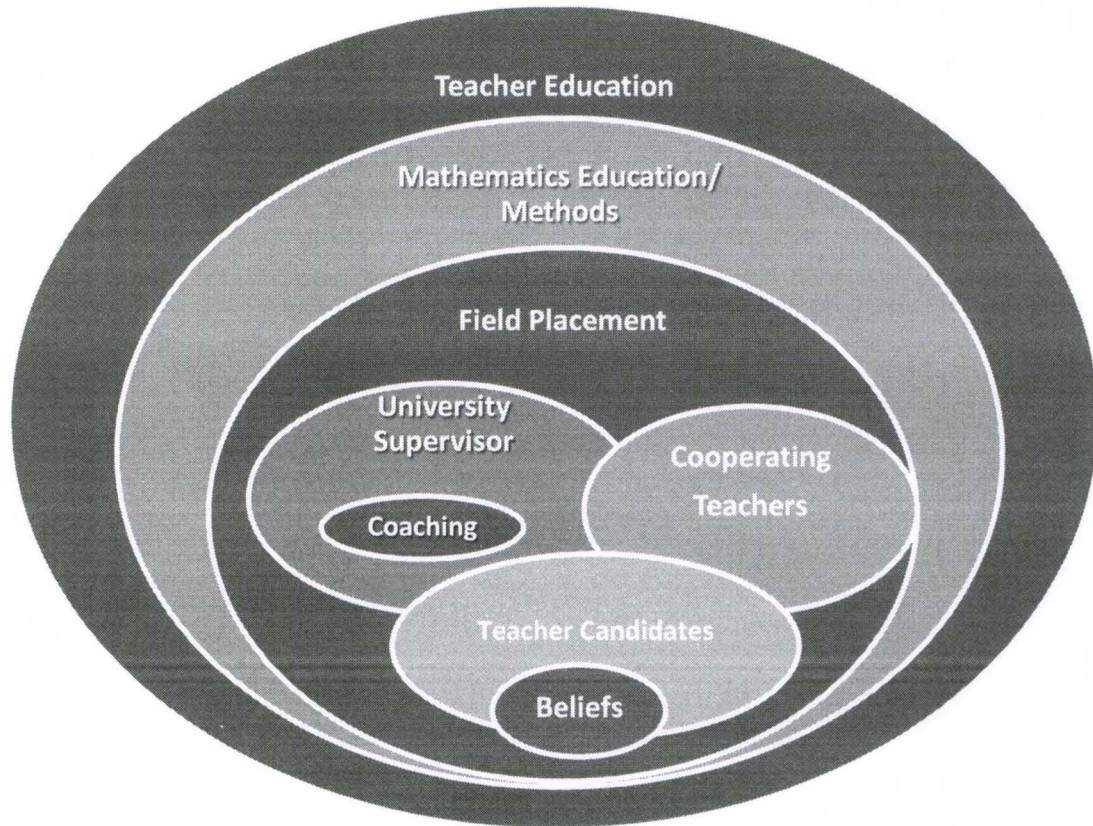
REVIEW OF LITERATURE

Introduction

This review addresses five areas of the literature: mathematics education, the field placement, university supervisors, coaching, and teacher candidates' beliefs and attitudes. A conceptual overview of the literature review is found in Figure 1 (on the next page). Figure 1 illustrates the key elements of the review. For the purpose of this study, the cooperating teacher will be referenced, but is not the focus of the literature search or study. The researcher recognizes the cooperating teacher as part of the dynamic of the field placement and will include some associated research within the field placement section. In addition, this chapter ends with a review on the best practices for professional development. Professional development is the treatment for this study and needs to be addressed.

Figure 1.

Conceptual Overview of the Literature Review



Livers, 2012

The first area discussed in this review is the research on the reform efforts in mathematics education and teaching. This includes the literature on the preparation of elementary mathematics teachers and their impact on kindergarten through fifth grade student achievement.

Second, the importance of the field placement is explored. Historically, the value of the field placement and student teaching gets high marks from recent graduates from the program as the most influential part of their education program. The value of field work and the downside of the field placements are addressed by an exploration of the

research. The triad of field placements and types of field placements are discussed. To close this discussion, suggestions for improvement are shared.

Third, the literature review highlights the role of the university supervisor. This is to clearly provide the roles and responsibilities of the university supervisors within the teacher education program. This section will discuss the types of supervision provided to candidates, along with the corresponding qualifications, and their impact in the supervision of teacher candidates. Obstacles that the university supervisors encounter will be examined to paint a picture of the barriers they face in doing their work. Finally, a summary of the literature on university supervisors in the content area of mathematics will be shared.

Fourth, the review examines the key literature on coaching. Because university supervisors are coaches for teacher candidates out in the field, it was necessary to examine the literature on coaching to provide the dispositions and professional development necessary to foster effective coaching practices. In this section, coaching will be defined and differentiated from mentoring, the elements of effective coaching practices will be identified, recommendations for training coaches will be shared, and the findings on the impact of coaching will be discussed. This section will end with the key findings about coaching mathematics.

Fifth, this literature review considers the research in the area of teacher candidates' beliefs and attitudes. This discussion includes both the research on teacher candidates' beliefs and attitudes about teaching and those specific to the teaching of mathematics. A breakdown of the different types of beliefs will be discussed, in addition to the impact of teacher candidate beliefs on their instructional practice.

Last, the review examines the best practices for professional development. Because professional development is part of the treatment for this study, key elements and design must be analyzed. Characteristics of quality professional development will be discussed to set the foundation for the implementation of professional development.

Literature Search

The use of these primary databases was the source for the bulk of this literature review: EBSCO Academic Search Premier, Education Resources Information Center (ERIC), Wilson Web, ProQuest Research Library, and ProQuest Digital Dissertations. The Google Scholar search engine was also used to locate sources. The following descriptors were used in the searches: mathematics education, mathematics reform, teacher education, university supervisors, field placements, field experience, instructional coaching, coaching mathematics, teacher effects, teacher effects in mathematics, teacher and teacher candidates' beliefs/ attitudes, and teacher and teacher candidates' beliefs/ attitudes about mathematics. Within these collected sources, additional sources were found through references in the literature. Other sources for this literature review were acquired from the collaboration with the dissertation chair, dissertation committee members, professors, peers, and a reference librarian.

Mathematics Education

The teaching of mathematics must improve. This requirement to change is based on national and international student assessments in order for American students to be viable in the 21st century (Van de Walle, Karp, & Bay-Williams, 2011). In 1989, the National Research Council (NRC) compiled twenty years of research that yielded a call to action: the country needs teachers with passion and expertise in the teaching of

mathematics and science. The *Everybody Counts* report (NRC, 1989) stated “mathematics opens doors to tomorrow’s jobs” (p. 2). This report recognized the growing need for mathematical minds as the world moved into a technologically based society, and the necessity to reform mathematics education. The report painted a bleak picture: students weren’t mastering basic concepts, there was a short supply of qualified mathematics teachers, traditional assessment strategies were ineffective for producing critical thinkers, curricula and instruction were out of date, and undergraduate mathematics was academically dormant. Mathematics education was in a state of emergency.

In 1989, the National Council of Teachers of Mathematics (NCTM) released standards to establish expectations for mathematics teaching. The expectations were founded on constructivist principles moving mathematics instruction’s focus from a shift of emphasis from procedures to conceptual understanding developed through problem solving. In 2000, NCTM released a revision to the 1989 standards, *Principles and Standards for School Mathematics*. Two other documents released by NCTM have been influential in changing the state of mathematics teaching and learning; they are *The Professional Standards for Teaching Mathematics* (NCTM, 1991) and *Assessment Standards for School Mathematics* (NCTM, 1995). These standards and documents provided expectations for both teachers and students. These expectations are at the heart of mathematics education reform.

In addition to standards, national legislation has also been a part of the growing response to improving mathematics achievement. The *No Child Left Behind act* (NCLB, PL 107-110) was established in response to students struggling and falling behind

compared to their international peers (U.S. Department of Education, 2008). NCLB legislation required districts and schools to be accountable for student success in mathematics and reading; all students are expected to reach proficiency or above each year on annual assessments. This was labeled “the “massification” of mathematics,” meaning that mathematics must be comprehensible to all (Adler, Ball, Krainer, Lin, & Novotna, 2005, p. 360).

Despite the standards, national reports and legislation, the instructional norm in mathematics classrooms however, remains the traditional teaching of mathematics based on procedures and skills. Mathematics is still being taught as it was at least 40 years ago (Ball, et al., 2001; Pajares, 1992). Teachers are expected to teach mathematics in ways that they have no experience using and use a curriculum that is vastly different from their expectations and knowledge (Adler, et al., 2005). As a result, American students still fall behind their international peers (Mullis, et al., 2008).

In addition to the lack of instructional transformation expected from the reform efforts, the literature clearly displays a bleak picture. Two problems are noted in the literature. First, elementary mathematics teachers aren’t prepared to teach mathematics (Ma, 1999), and second, there is a trend that more teachers aren’t qualified to teach mathematics in our struggling schools (Almy & Theokas, 2010). According to the Education Trust, in high need areas, there is prevalence of emergency certified and under qualified teachers with little or no mathematics content background (Almy & Theokas, 2010). In a nation where high stakes testing and standards based curricula drive the instructional practice, the research highlights little change in instruction. The key factor to changing mathematics instruction and making the mathematics education reform

movement a success is the teacher (Battista, 1994). In order to increase student achievement, teachers must design effective instruction and choose appropriate materials (Kolstad & Hughes, 1994).

The teacher's philosophy of mathematics contains his/ her beliefs about mathematics and how mathematics works and is learned (White-Fredete, 2010). This philosophy has to be identified in mathematics education courses. This is the pivotal piece in order for teachers to meet the goal of mathematics reform; through the identification of the teacher candidate's mathematics philosophy, teacher candidates become aware of their beliefs (White-Fredete, 2010). Handal and Herrington (2003) found that it is imperative for mathematics education to address teacher candidates' beliefs; they feel this is the key to mathematics curricular reform. Bray (2011) agreed with this finding. "Teachers' knowledge and beliefs can make a difference in how much change we can expect and how soon that change might occur" (Bray, 2011, p. 35). These beliefs are tied to a teacher's instructional practice (Bray, 2011), and must be identified by mathematics educators, teachers, and teacher candidates in order to reform the teaching of mathematics. The identification of beliefs can be disturbing and lead to feelings of inadequacy (Ball, 1990) and teachers will need support and guidance during this process (Bray, 2011).

Teachers drawn to elementary school teaching often do not have a strong passion to teach mathematics (Philippou & Christou, 1998). Yet, the often single offering of a mathematics education course has been found to increase content knowledge (Leonard, et al., 2009; Stevens & Wenner, 1996). It is more effective in increasing content knowledge and changing beliefs than increasing the number of mathematics content courses (Stevens

& Wenner, 1996). On the other hand, Kajander (2010) found that teacher candidates did increase their content knowledge but it was not enough to evoke instructional change. Regardless of this contrast, mathematics educators have to respond and provide the necessary supports to help them address their beliefs, (Fives & Buehl, 2008; Leavy, McSorley & Botè, 2007; Ng, Nicholas & Williams, 2009) increase their content knowledge (Kagan, 1992; Pajares, 1992), and boost their confidence in teaching mathematics (Ng, Nicholas & Williams, 2009).

“Quality instruction depends on teachers, and so their preparation and continuing professional development is crucial” (Adler, et al., 2005, p. 360). This puts the burden on teacher preparation programs and more specifically on mathematics educators. The program and mathematics educators must reflect on their practice and program in order to increase the effectiveness of their program (Reeder, Utley & Cassel, 2009). The mathematics educators work with teachers in the field to prepare and train teacher candidates for certification. However, most teachers have not met the reform standards (Frykholm, 1998; Weiss, 1995), and yet these teachers are selected to be cooperating teachers to teacher candidates. Placing teacher candidates with these teachers creates the possibility of allowing these traditional practices to be passed on (Frykholm, 1998). This is a vicious cycle to break.

In conclusion, mathematics education began a revolutionary reform in 1989 shifting the focus of student learning from procedural knowledge to conceptual understanding. The reform has been slow in changing the instructional practices of teachers. In order to increase the reform efforts teacher education programs must prepare

new teachers for the reform expectations. This requires an intentional approach to coursework and the field placement.

The Field Placement

The field placement is one component of teacher preparation programs that receives both accolades and criticisms. Dewey (1938) first saw the importance of the field placement as a necessary component in the preparation of teacher candidates. Others made similar claims that the field placement component of teacher preparation programs is a vital experience in learning to become a teacher (Cole & Knowles, 1993; Dewey, 1938; McGlamery & Harrington, 2007). The field placement is the avenue where teacher candidates are “implementing prior knowledge about theory and methods, experiencing anomalies in this implementation, and, perhaps most importantly, reconstructing prior knowledge to account for experience and to create for oneself more coherent concepts about teaching” (Jones & Vesilind, 1996, p. 115). The field placement is the crossroads where theory and practice intersect (McGlamery & Harrington, 2007).

This section will discuss the essential elements and benefits of the field placement. Also discussed will be the negatives of field placements, types of field placements, suggestions for improvement, and the key people involved in teacher candidate support.

The Key Elements of Field Placements

Field placements are a key aspect of teacher preparation. Effective field placements have been described as “safe, nested contexts,” blended principles and “a reflective focus on the work” (LaBoskey & Richert, 2002, p. 32). Studies have investigated the attributes that make it an essential part of teacher preparation programs

(Cruickshank & Armaline, 1986; Guyton & McIntyre, 1990). In a study examining 15 institutions in New York, it was determined that coherence was an important characteristic for teacher education programs (Grossman, Hammerness, McDonald, & Ronfeldt, 2008). By coherence Grossman et al., 2008 meant a common vision for teaching and learning, a common alignment between the courses and field experiences, and a common goal that all components of the teacher preparation program echo this coherence. Another attribute of successful field placements is the focus on reflection.

The Benefits of Field Placements

The field experience has been found to produce a number of benefits. Teacher candidates commonly credited the field experience to be the most beneficial aspect of their teaching program (Purdy & Gibson, 2008; Sadler & Klosterman, 2009). The field experience is the avenue where teacher candidates can build self-esteem and confidence (Gurvitch & Metzler, 2009). The field experiences before student teaching have been credited to increase confidence among teacher candidates (Scherer, 1979). The field experience allows teacher candidates to experiment with strategies and gain experience in classrooms full of students. This allows them to worry less about classroom management and focus on content and pedagogy, because they become more comfortable and confident in the classroom (Watzke, 2003). In the field, the teacher candidates are able to understand the connection between motivation and student success by moving out of the survival stage (Watzke, 2003). This was concluded after a year and a half analysis of a teacher program.

Field placements that require and create an atmosphere for reflection also increase the success and learning of teacher candidates (Boz & Boz, 2006; Cole & Knowles, 1993;

McGlamery & Harrington, 2007). Through the use of a reflective journal, McGlamery and Harrington (2007) concluded that the field experience could be the catalyst to help teacher candidates grow into reflective practitioners. Quality course assignments designed for the field placement produce opportunities for reflection (LaBoskey & Richert, 2002) as well as having a common placement with a peer (Anderson & Radencich, 2001). Through reflection and field placements, teacher candidates can move from a teacher centered philosophy to a student centered one (Kasten & Buckley von Hack, 2008).

The Downside to Field Placements

In contrast to the positive aspects and value of field placements, the field placement has also been labeled the weakest link (Wideen, Mayer-Smith, & Moon, 1998) and “problematic” (Burant, & Kirby, 2002). Teacher candidates often have their “hopes, images, and expectations all too often are quickly shattered by exposure to certain realities of schools, classrooms and teaching” (Cole & Knowles, 1993, p. 457). This is due to the field placement being created without a purpose and a weak connection between the field and teacher preparation program. There isn’t enough focus on the complex dynamic of learning to teach, instead teacher programs place the importance on the behaviors found in a classroom (Cole & Knowles, 1993).

Cohesiveness among the program, courses, and field work is often lacking (Feiman-Nemser, 2001; Sykes, Bird, & Kennedy, 2010) leaving the teacher candidate unsure of his/ herself and the teacher preparation program (Grossman et al., 2008). Candidates’ worry and sense of low efficacy also stems from the university supervisor and cooperating teacher not being fully integrated or included within the program (Sykes,

Bird, & Kennedy, 2010). Another ramification of the disconnect among the university supervisor, cooperating teacher, and the teacher preparation program is the inconsistencies found in the classroom placements; teacher candidates cannot rely on the placements to meet their needs due to factors like scheduling and being able to observe best practices (Feiman-Nemser, 2001).

Field experiences prior to student teaching are also found to be a problem (Burant & Kirby, 2002) because they can continue the status quo of teaching by perpetuating and solidifying teacher candidates' predetermined beliefs (Gomez, 1996; Haberman & Post, 1992). They can be problematic because the cooperating teachers may not understand the purpose and expectations of these novice teacher candidates (Anderson, 1993). Having teacher candidates conduct mere observations is not of value unless intentional reflection is embedded within the field placement (Boz & Boz, 2006; Burant & Kirby, 2002; Cole & Knowles, 1993) or teaching them how to observe (Boz & Boz, 2006; Mewborn, 2000). Without the reflection, stereotypes and preconceived beliefs can become stronger (Burant & Kirby, 2002).

Other research focused on the quality of field placement experience. A weak field placement within the first semester of the teacher preparation program is more harmful than when it is in the second semester (LaBoskey & Richert, 2002). This is due to the fact that the teacher candidates have one semester behind them and feel more confident in handling a weaker field placement. Weak field placements even cause strong teacher candidates to struggle (LaBoskey & Richert, 2002). However, work needs to be done to eliminate weak field placements (LaBoskey & Richert, 2002). Ronfeldt (2010) found that

“learning to teach in difficult-to-staff field placement schools are associated with lower teacher effectiveness and retention” (p. 32).

Communication among the cooperating teacher, university supervisor, and the teacher educators for the education program can also be problematic (Anderson, 1993). Cooperating teachers are not always knowledgeable of the expectations and purpose of the field experience (Anderson, 1993). University supervisors also can have a deficiency in communication and awareness of program guidelines; they aren’t always abreast of the philosophy and best practices advocated by the program (Yarrow, 1994). This causes confusion for the teacher candidates.

The Triad of Education Programs

Three individuals are important to the field experience. They are the cooperating teacher, university supervisor, and the teacher candidate. “The university supervisor and cooperating teacher help students to grow, develop, and achieve during the student teaching experience” (Ediger, 2009). Some studies focused on the roles and responsibilities of the cooperating teacher and university supervisor since they are key players of teacher preparation programs in providing a connection between theory and practice.

Some teacher candidates identify the cooperating teacher as the most important element of the field placement (Bates & Rosaen, 2010; Borko & Mayfield, 1995); others identify the university supervisor as the important element (Smith & Souviney, 1997). Some of the key findings regarding the cooperating teacher include suggestions about the selection process (Boz & Boz, 2006; Sykes, et al., 2010). Cooperating teachers need to be selected based on a clear set of standards and need appropriate training (Boz & Boz,

2006). They need to be a part of the conversations and collaboration between the universities and the placement schools in order to be congruent with the philosophy and expectations of the teacher program (Sykes, et al., 2010). Teacher educators also need to “build stronger alliances with practicing teachers (Sykes, et al., 2010, p. 474).

In order to increase the cohesiveness of a program, university supervisors need to conduct more observations and have more contact with full-time program faculty (Grossman, et al., 2008). As a result of Kern’s (2004) study The College of New Jersey added two seminars per semester for university supervisors and program faculty to discuss and reflect on program goals and practices. Field placements that are well-matched with the expectations, goals, and views of the teacher preparation program are more likely to yield an increase in more successful teacher candidates (LaBoskey & Richert, 2002). A qualitative study examining the field experience for a mathematics methods course determined that the university supervisors need to be hired and placed to correspond to the purpose of the field placements (Mewborn, 2000).

The Mathematics Field Placement

Field experiences prior to student teaching can produce negative effects (Boz & Boz, 2006; Burant & Kirby, 2002; Wideen, et al., 1998). In the area of mathematics, this can be even more detrimental. Often these placements do not contain the type of mathematics that is advocated for in the standards and teacher education program (Phillipp et al., 2007). This hinders a mathematics methods student from observing and experiencing high quality mathematics instruction (Phillipp et al., 2007).

If teacher education is to become a more effective intervention in preparing elementary teachers to teach mathematics, we need to examine the influence of

different kinds of teacher education experiences on teacher candidates' knowledge about and orientations toward mathematics and math teaching and learning, as well as on what they actually do in their classrooms. (Ball, 1988, p. 16)

The mathematics methods course needs to contain tangible, hands-on experiences in order to increase teacher candidates' knowledge of concepts and procedures (Vinson, 2001). When teacher candidates understand these concepts and procedures then they are capable to teaching them to students (Vinson, 2001) out in the field. Competent teaching leads to an increase in student achievement and student confidence (Vinson, 2001).

Teacher candidates enter mathematics methods courses and field experiences with a “thin understanding of mathematics” (Ball, 1990). This means that they might know what is appropriate and expected in teaching mathematics, however they revert back to the traditional methods from their past out of fear or lack of confidence (Ball, 1990).

However, it is this dual experience that can yield promising results. Mathematics methods courses need to focus on inquiry based mathematics and engage teacher candidates with problem solving (Barlow & Cates, 2006), analyzing student work, and reflecting on themes and patterns (Olson & Barrett, 2004). Effective professional development in the area of mathematics also advocates for these activities to change beliefs and the teaching practice (Loucks-Horsley et al., 2010; Smith, 2001; Stein et al., 2009). Professional development for in-service teachers or teaching preparation for pre-service teacher candidates must revolve around “problems of the practice” (Darling-Hammond & Ducommon, 1999; Mundry & Loucks-Horsley, 1999; Smith, 2001). This allows teachers and teacher candidates to have ownership and power; teacher reflection and analysis of their instructional practice is the key to creating a culture of change. In

order to comply with this expectation, professional development and mathematics methods activities should include mathematical task analysis and development, case study evaluations, and collaborative activities like lesson planning and assessment design (Smith, 2001; Stein, Smith, Henningsen, & Silver, 2009). With teacher candidates, if they participate in these types of activities in their methods course and then observe and work with students in their field placements, they are more likely to teach reform based mathematics and experience a change in their beliefs (Crespo, 2003; Phillipp et al., 2007). Analyzing student work has proven effective with teacher candidates to help them understand content and student thinking (Cooper, 2009).

Room for Improvement

Many researchers and educators offer their advice for the redesign of field placements in order to increase the effectiveness. Gurvitch and Metzler (2009) concluded that teacher candidates should experience realistic and challenging field placements; they believe that this would improve teacher candidates' self-esteem before they student teach. Many studies were concerned with the field placement preparing teacher candidates to teach diverse learners (Lee & Herner-Patnode, 2010). Evidence points to the benefit of placing teacher candidates in urban schools to increase comprehension and insights about the needs of diverse students (Lee & Herner-Patnode, 2010); however, the urban placements can solidify stereotypical views about students (Gomez, 1996; Haberman & Post, 1992) if guided reflection is missing from the experience (Lee & Herner-Patnode, 2010).

In a qualitative study of 41 teacher candidates, Boz and Boz (2006) identified a few problems with field placements. They found teacher candidates were not learning as

much in their second semester in the field due to similar tasks and observations being required that match their first semester. Another finding was an obvious disconnect between the philosophy of the program and the practice out in schools. During the final phase out in the field, teacher candidates felt that the cooperating teachers hindered their experience by not allowing them to teach according to the methodology of their courses, or they interrupted, took over, or changed the teacher candidates' lessons (Boz & Boz, 2006).

Alternative Field Placements

Within the recommendations, there is also a call for different types of field experiences that include working with students outside of school time and those that include families and communities (Burant & Kirby, 2002; Coffey, 2010); these types of experiences will increase the effectiveness of teacher candidates working with diverse student populations (Burant & Kirby, 2002; Coffey, 2010). Similarly, Wasserman (2010) found from a study of 50 teacher candidates that the inclusion of service learning within the field placement yielded positive results in developing relationships with students. These types of community based field experiences assist the teacher candidates in their communication skills with students and their colleagues (Coffey, 2010).

Internationally, the evidence points toward similar results of including alternative placements like those in the community as part of the field placement requirements; Purdy and Gibson (2008) studied the effects of alternative placements in an education program in Ireland. The findings included an increase in these skills: communication, teamwork, flexibility, and self-motivation. It is clear that alternative placements are an

important component to be included in the teacher education programs (Burant & Kirby, 2002; Coffey, 2010; Purdy & Gibson, 2008; Wasserman, 2010).

Virtual field placements are also a possibility for alternative placements. Twenty first century learning is abundant with the use of technology. As more and more K-12 classrooms are using technology to teach effectively, teacher education programs need to also model these methods and strategies. Virtual field placements allow students to observe and interact with classrooms via the Internet (Karchemer-Klein, 2007). The benefits include more intentionality of classroom choice. For instance, if the methods professor is covering the topic of fractions, then the virtual classrooms for the field work and observations would be classrooms teaching fractions. There would be congruence between the theory of the methods class and the practice in the virtual classroom observations. Five specific benefits have been noted in the literature. They are: (a) exposure to various teaching/ learning environments; (b) creation of shared experiences; (c) promoting reflectivity; (d) preparing students cognitively, and (e) learning about technology integration (Hixon & So, 2009). Grable, Kiekel, and Hunt (2009) also found the added benefit in meeting the needs of students with extenuating circumstances, like deployment. There are limitations to virtual field placements. These include the lack of interaction with professors and instructors, a limited view of reality, finding the applicable classrooms, and technical problems (Hixon & So, 2009). While they can never replace the authentic, traditional placement, virtual placements can provide a nice addition (Karchmer-Klein, 2007).

To summarize, the benefits of the field placement far outweigh the negatives. “Greater attention needs to be paid to preparing pre-service teachers for the realities of

the field experiences and to helping them make sense of their encounters in light of their prior expectations” (Cole & Knowles, 1993, p. 458). Teacher candidates’ first field experience is actually the thirteen years spent in K-12 classrooms in what Lortie (1975) called the “apprenticeship of observation.” Through this apprenticeship teacher candidates formulate beliefs and ideas about teaching and learning. The authentic experience teacher candidates encountered in classrooms is pivotal to their growth and development as they become teachers (Dewey, 1938). Teacher candidates need the exposure to students, teaching, learning, and involvement with parents and families. There are several types of field experiences that prove beneficial; virtual placements and community based placements have seen positive results with teacher candidates. Coupled with the field placement, there must be authentic assignments from the methods course to increase these benefits, and the necessary support in the field to ensure successful implementation.

University Supervisors

“The quality of clinical experience depends heavily on the kind of coaching, supervision, and support prospective teachers receive as they develop their practice” (Grossman, 2010, p.5). University supervisors provide a necessary role within teacher education programs. The supervision of teacher candidates is vital to the success of the program and the candidates (Albasheer et al., 2008). The university supervisors are the link that provides the communication between the university and the field placement schools. Zeichner (2002) concluded that the university supervisors provided the necessary support for teacher candidates to fuse the foundational theories provided by coursework to the practice of teaching. Many studies have identified the university supervisors as critical players in the education and development of teacher candidates

(Blanton, Berenson & Norwood, 2001; Freidus, 2002; Frykholm, 1998; LaBoskey & Richert, 2002; Smith & Souviney, 1997).

Providing committed university candidates with opportunities for intense reflection with actively engaged university supervisors will likely produce novice teachers who are better prepared upon first entering the classroom. Also, it is likely that candidates who were involved in a learning community of candidates like themselves, facilitated by dedicated university supervisors, will remain committed to providing consistent, quality education and instruction on a long-term basis. (Kent & Simpson, 2009, p. 697)

This section will cover: the roles and responsibilities of university supervisors, the desired credentials and qualifications, the impact of university supervisors, obstacles and challenges, and the supervision of mathematics instruction.

The Roles of a Supervisor

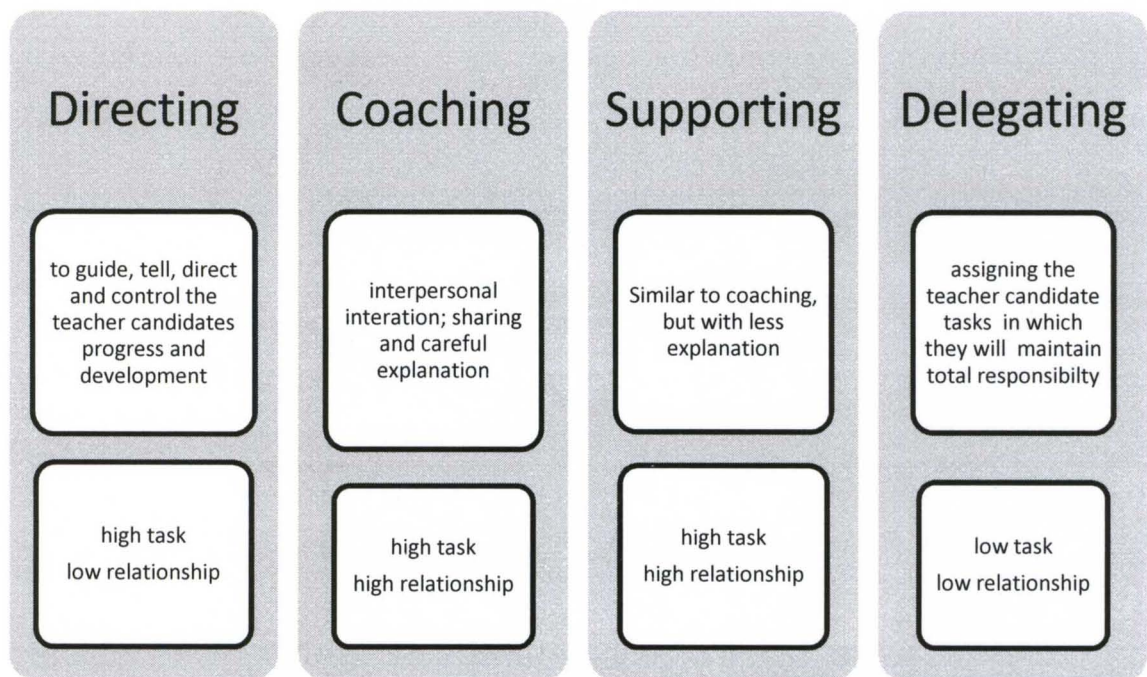
Research and scholarly writing outlines the roles and responsibilities for university supervisors. Traditionally, university supervisors have maintained a supervisory role concerned with the mundane activities of checking assignments, reviewing portfolios, reading lesson plans in contrast to having dialogue about the art and science of teaching. They also provide an authoritarian voice that gives the teacher candidates little room for personal style and reflection. Blanton, Berenson, and Norwood (2001) believe university supervisors should move past this “superficial role” for a more important and effective role. The university supervisor’s most important role is that of a mentor; the supervisor aids teacher candidates in comprehending the dimensions of teaching and clearly defines best practice (Fernandez & Erbilgin, 2009; Smith &

Souviney, 1997). The university supervisor facilitates the teacher candidates internalizing lessons learned in their methods classes into effective teaching practices in their field experience (Ediger, 2009).

The supervisory role includes four roles of supervising: directing, coaching, supporting, and delegating (Ralph, 1991). These are defined in Figure 2 below.

Figure 2

The Four Roles of the Contextual Supervisory Approach



Ralph (1991)

These roles of support are part of what Ralph (1991) called the contextual supervisory approach. This is an approach where the university supervisor can respond to the teacher candidates' individual situations and needs by matching their role to the condition of the teacher candidate (Ralph, 1991). Glickman (1980) also found that supervisors need to match their level of support to the teacher candidates' developmental levels. There are varying levels of involvement and personal commitment amongst the

roles (Ralph, 1991). These have similarities to others who have defined the roles of university supervisors. This list of roles or types of supervision includes:

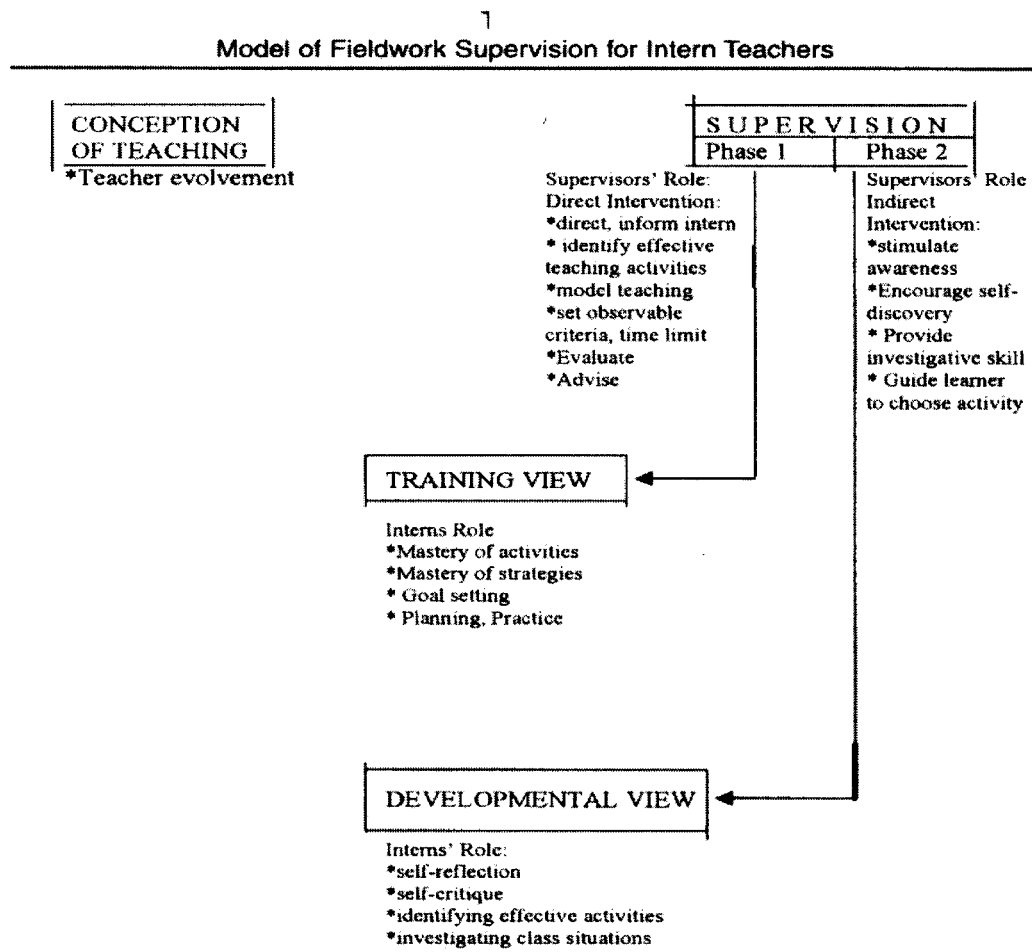
- a.) Direct
- b.) Non-directive
- c.) Alternative
- d.) Creative
- e.) Collaborative
- f.) Self-help-explorative

Freeman (2000) and Randall and Thornton (2001) identified the first three as types of supervision. They distinguished between the level of involvement and direction provided by the university supervisor. The direct supervisor acts as an evaluator and provides explicit directions and next steps. The non-direct supervisor provides support and understanding and allows the teacher candidates to solve their own problems. The supervisor who provides alternative support does so by providing possibilities and choices. Gebhard (2000) is credited with the remaining roles. The collaborative university supervisor is in a partnership with the teacher candidate; they work together to solve problems. The creative supervisor is resourceful and uses any means necessary to support and guide the teacher candidates. These supervisors move in and out of all of these different roles. The self-help-explorative supervisor provides support based on the foundation of his/ her experiences of teaching by using examples, situations, and problem solving techniques. Using this identification of university supervisors roles, Ajaya and Lee (2005) created a fieldwork model for the supervision of teacher candidates using three views of supervision in order to aid in the professional development of teacher

candidates (p. 267). This model is found in Figure 3. The Ajaya and Lee (2005) model of field work supervision highlights two roles of the university supervisor in two phases: Phase One, Direct Intervention and Phase Two, Indirect Intervention. This model coincides with other models like Glickman (1980) and Ralph (1991) where the supervisor adjusts the type of supervision based on the phase of the teacher candidate. The university supervisor provides the necessary support to move the candidate forward.

Figure 3

Model of Field Work Supervision for Intern Teachers



(Ajaya &. Lee, 2005).

Coupled with the roles that the university supervisors fill are duties and tasks necessary for the job. The university supervisor must be able to perform these duties proficiently: feedback conferences, observations, and maintain the timeline for program requirements (Lamont & Arcand, 1995). The affective role of university supervision is to provide a caring, encouraging atmosphere (Lamont & Arcand, 1995) that helps teacher candidates to build confidence (Ediger, 2009).

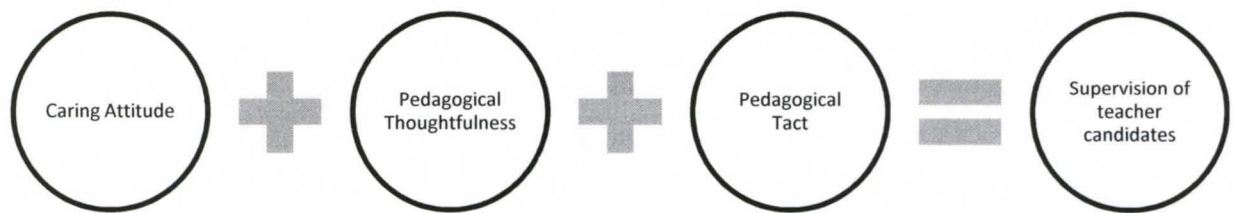
University supervisors who engage their teacher candidates in conversations using questioning strategies targeted at the candidate's "zone of proximal development (ZPD)" provide the necessary support to impact the learning and growth of the teacher candidate (Blanton, et al., 2001). This behavior has been labeled as "educative supervision" (Blanton, et al., 2001) and has been noted to be a successful model that fosters a reflective teaching practice that allows the teacher candidates to grow and internalize concepts (Blanton, et al., 2001; Fernandez & Erbilgin, 2009). Warford (2011) expanded Vygotsky's idea to the *zone of proximal teacher development (ZPTD)*. His concept called for the reworking of the education program to include the support and methods to be adjustable to the teacher candidates' needs. This would call for the university supervisor to be adaptable in his/ her methods. This role identifies the university supervisor as an instructional coach in contrast to the evaluator in the supervisory model (Anderson & Radencich, 2001). By being "mediators of action" university supervisors provide the opportunity of teachers to think about their thinking (Wertsch, 1998). Teacher candidates need opportunities to reflect and converse about their development and growth (Fernandez & Erbilgin, 2009). In fact they value the discussions, feedback and opportunities to reflect (Anderson & Radencich, 2001). The university supervisor and

cooperating teacher provide a community where the teacher candidates can collaborate and have dialog about their teaching practice and progress (Blanton, et al., 2001; Frykholm, 1998). By mediating the thought processes of teacher candidates, internalization can take place and teacher candidates can grow into qualified teachers (Wertsch, 1998).

Cuenca (2010) outlined a conceptual framework for university supervisors based on his literature review. He identified the need for a caring attitude, pedagogical thoughtfulness, and pedagogical tact in the supervision of teacher candidates as displayed in Figure 4.

Figure 4

Conceptual Framework for University Supervisors



(Cuenca, 2010)

This framework provides “meaning” to those members involved (Cuenca, 2010). Within this framework, Cuenca (2010) detailed each of the three components. Caring attitudes provide security to the relationship between the teacher candidate and the university supervisor. It allows the university supervisor to remain “sensitive and receptive” to the problems and issues of the teacher candidates. Caring attitudes provide a “pedagogical eros” or love. Pedagogical thoughtfulness fosters a reflective practice. It allows the university supervisors to highlight the elements of student teaching that will allow the

teacher candidate to grow. Pedagogical tact allows the university supervisor to help the teacher candidate understand the “meaning” behind their actions. The university supervisor must have patience and look for the opportunities to connect theory and practice. This framework paints a picture much like that of a coach.

Credentials and Qualifications.

The university supervisor’s background and credentials are important to the experience of teacher candidates (Fernandez & Erbilgin, 2009). Important characteristics include: knowledge of the education program (LaBoskey & Richert, 2002), and interest in student development, ability to give constructive criticism, and a willingness to collaborate (Yarrow, 1994).

Yarrow and Millwater (1996) examined three characteristics of university supervisors in a qualitative study. They used a questionnaire that contained 55 questions in regard to the personal, professional, and procedural characteristics of university supervisors and 16 questions about the practicing schools. They administered this questionnaire to four groups: teacher candidates, cooperating teachers, teacher candidates, and the school coordinators. They found that the teacher candidates were very critical of the university supervisors. Teacher candidates found them to be lacking in many areas that include: consistency, flexibility, open-mindedness, understanding, tactfulness, friendliness, and their qualifications. Teacher candidates also reported the university supervisors were not cognizant of their developmental levels and didn’t communicate expectations clearly (Yarrow & Millwater, 1996). From this study it is clear that university supervisors need to possess these characteristics.

The Impact of University Supervisors

The impact of university supervisors on the teacher candidates has received mixed findings. Studies reveal that university supervisors have a positive influence. This influence includes building confidence in teacher candidates and providing them with an experience to grow as a teacher (Chaliès, Bruno-Mèard, Mèard, & Bertone, 2010).

University supervisors are an important component in teacher preparation programs by providing a rich and meaningful experience and contributing to the growth and development of teacher candidates (Albasheer et al., 2008). Teacher candidates find the feedback and guidance from university supervisors to be beneficial (Anderson & Radencich, 2001). Some teacher candidates even claim that the university supervisor was the most important component of their program (Smith & Souviney, 1997). The post-observation conference that facilitates a reflective practice is the experience that is valued the most (Bates & Rosaen, 2010). The positive effects of university support are increased when teacher candidates are doubled up in placements as partners (Bowman & McCormick, 2000); this allows teacher candidates to coach each other and process content and pedagogy (Bowman & McCormick, 2002).

The university supervisor's role of providing the bridge between theory and practice is crucial for the teacher preparation programs (Grossman et al., 2008). They assist in making the theory tangible in the field experience; this includes the teacher education program's philosophy and core values (LaBoskey & Richert, 2002). Gimbert and Nolan, Jr. (2003) found that the role of university supervisors was more effective in Professional Development Schools (PDS). This dynamic provided the university supervisors with identification and ownership to a school culture. This finding matches

Smith and Souviney's (1997) finding that when university supervisors are assigned one school, the overall effectiveness of the program increases.

Obstacles and Challenges

University supervisors face numerous obstacles that interfere with their work. There have been studies that identified barriers to the relationship between the university supervisor and the teacher candidates. Borko and Mayfield (1995) identified areas in which university supervisors found to be detrimental to building relationships with their teacher candidates; they are time, institutional requirements, and inadequate conferences with the teacher candidates. Overall, university supervisors felt that there was not enough time to do more than the necessary requirements of the pre-observation conference, observation, and post-observation conference (Anderson & Radencich, 2001; Borko & Mayfield, 1995). Many had teacher candidates in more than one school which required driving time and then led to scheduling problems. The university supervisors felt dissatisfied with their conferences with the candidates because of the lack of depth in the dialogue (Borko & Mayfield, 1995).

Other studies have identified struggles between the university supervisors and the university. One problem that interferes with the work of the university supervisors is that many have little "connection to or authority" within the university's teacher program (Zeichner, 2002, p. 60). University supervisors are often not full time teaching staff. University supervisors struggle with the institutional requirements that include multiple schools and scheduling (Borko & Mayfield, 1995). Another issue in bridging the two worlds is a lack of communication between the cooperating teacher, university supervisor, and teacher educators in charge of the programs (Anderson, 1993). It has been

noted in the literature that university supervisors should be a part of the dialogue about the teacher preparation program's idea of best practices and expectations (LaBoskey & Richert, 2002; Lee & Herner-Patnode, 2010).

Another challenge for university supervisors are the requirements and pressures of the No Child Left Behind (NCLB) legislation. Bates and Burbank (2008) conducted a case study of a university supervisor analyzing the effects of the NCLB high stakes accountability. NCLB was found to impact the behavior and support the university supervisors provide. University supervisors were more likely to focus on the language of the standards than the individual needs of the teacher candidates (Bates & Burbank 2008). The supervision was more global with feedback about the big picture rather than specifics about the teacher candidates' individual situations. One positive that has resulted from the NCLB legislation and the supervision of teacher candidates is the focus on assessments for students (Bates & Burbank, 2008). More teacher candidates began to focus on formative assessments.

Supervising Mathematics

Few studies have examined the roles of university supervisors in the content area of mathematics (Fernandez & Erbilgin, 2009). It is critical that university supervisors who provide supervision in the content area of mathematics have their beliefs, expectations, content knowledge and pedagogy congruent with the current reform standards and expectations in mathematics (Slick, 1998). Fernandez & Erbilgin (2009) found that university supervisors spent more time conferring about the content of mathematics and the teaching of mathematics in comparison to cooperating teachers. This makes the role of the university supervisor a key player to the internalization of the

practice of teaching standards based mathematics. University supervisors need to have an expertise in mathematics in order to provide effective support (McDuffie, 2004; Fernandez & Erbilgin, 2009).

McDuffie (2004) found that university supervisors must use teacher candidates' beliefs and experiences as the "context for learning" (p.55). University supervisors need the time and opportunity to discuss mathematics lessons and instruction prior to the teaching (McDuffie, 2004). This means that a planning conference is crucial to the growth and development of teacher candidates in the teaching of mathematics coupled with the post conference (McDuffie, 2004). University supervisors must foster a reflective practice with the teacher candidates in order for them to have an awareness of their thoughts and beliefs (McDuffie, 2004.)

In conclusion, the university supervisor provides an important role of support and guidance to the teacher candidates. He or she also links the teacher education program to the authentic experience of the field placements. There are numerous roles of university supervisors, with the role of a coach getting the best results.

Coaching

The value of an instructional coach is noted in legislation, national organizations, induction processes, and in high performing schools. The No Child Left Behind (NCLB) Act identifies coaching as a means of effective professional development of teachers. Many national organizations like National Council of Teachers of Mathematics, Alliance for Excellent Education, National Staff Development Council, and Association for Supervision and Curriculum Development support coaching as a means for increasing teacher effectiveness (Sailors & Shanklin, 2010). Induction and certification programs

also use coaching to assist teachers in the process (i.e. National Board Certification, The Kentucky Teacher Intern Program). Wong and Wong (2008) noted that highly effective schools employ the use of instructional coaches.

NCLB created a climate of high stakes accountability that places extreme pressure on schools and districts to meet the needs of all students in the area of mathematics and reading. The release of the Common Core Standards (CCSSO) in 2010 placed new demands on teachers in the teaching of mathematics and literacy. Teachers need continued support and professional development in order to meet the demands (Darling-Hammond, 1998; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; Smith, 2001) of national legislation and the adoption of new standards. This is not a stagnant profession with a recipe for success found in a teaching manual. The teaching profession requires continuous maintenance, examination and tune-ups. Professional development has to be provided to them in a systematic, intentional and relevant manner (Joyce & Showers, 2002). The traditional model of the one time, “sit and get” professional development is not considered high quality (Smith, 2001). Just like teaching, professional development must be of high quality in order to induce a change in instructional practice. Coaching is considered high quality professional development (Joyce & Showers, 2002). In their comparison of four components of professional development, Joyce and Showers (2002) concluded that coaching yields the highest transfer of knowledge, skill, and attainment as seen in Table 1.

Table 1

Professional Development Comparison

Training Components and Attainment of Outcomes in Terms of Percent of Participants			
Components	Outcomes		
	Knowledge	Skill	Transfer
Study of Theory	10	5	0
Demonstrations	30	20	0
Practice	60	60	5
Coaching	95	95	95

Joyce & Showers (2002, p. 78)

In pre-service teacher programs, university supervisors are hired by colleges of education to provide supervision, support and guidance that the full time professors cannot give due to work loads, schedules and time. University supervisors are ultimately coaches in the field (Slick, 1997). Anderson and Radencich (2001) found that university supervisors who filled the role as a coach were more effective than those who were in the supervisory role. Coaches observe, provide feedback, facilitate in lesson and unit planning, and locate resources. Additionally, coaches build key relationships founded on trust and respect (Joyce & Showers, 2002; Tschannen-Moran, 2004). Teacher candidates learn to accept feedback, new ideas, and advice on planning and implementation of lessons through this coaching process.

A review of the literature revealed the qualities attributed to good coaches or supervisors fall into three categories: knowledge, disposition, and commitment (Borman

& Feger, 2006; Obara, 2010; Saphier & West, 2010). The literature has also declared best practices for providing support to coaches (Charalambous, Philippou, & Kyriakides, 2008; Veenman & Denessen, 2001) and content specific coaching in the area of mathematics (Staub, et al., 2003). This literature review highlights the differences between mentoring and coaching, effective qualities of coaches, and mathematical coaching. The review will begin by addressing the difference between coaching and mentoring.

Coaching and Mentoring

Understanding the characteristics of effective coaching is vitally important: “Good teachers of children are not necessarily good teachers of adults” (Jonson, 2002, p. 17). This means the selection for coaches needs to be more than just the identification of a good teacher (Obara, 2010). Coaches work with adult learners in a situational context that differs from a classroom of students. Saphier and West (2010) define coaching as “a systematic approach to improving student learning” (p. 47). Sailors and Shanklin (2010) provide an expanded definition by stating, coaching is, “sustained classroom-based support from a qualified and knowledgeable individual who models research-based strategies and explores with teachers how to incorporate these practices using the teacher’s own students” (p.1). Coaching and mentoring are sometimes used interchangeably, but they are clearly two different processes. Mentoring is seen as an annual event and not a long-term, lasting relationship (Wong and Wong, 2008). Hansen (2010, p. 76) defined mentoring as “Mentoring is a professional role that requires knowledge and skills beyond those needed to be an exemplary teacher.” Another definition would be that of an older expert taking a younger, less experienced person

under the wing to support and mold (Winton, McCollum, & Catlett, 1997). Coaching is a professional development process that is not locked into a one-year commitment (Wong and Wong, 2008). “Coaching involves helping participants implement newly acquired skills, strategies, or models on the job” (Winton, McCollum, & Catlett, 1997). For the purposes of this study, the terms coach and coaching will be used.

Roles, Goals, and Duties of a Coach

Defining the roles and responsibilities of the coach is important to the success of the coaching. A coach needs to have clear expectations. The hiring organization should have clear guidelines for a coach to ensure a set focus, priorities, and duties (Graves, 2010). The coach and the coachee also need to set goals for the relationship (McGatha, 2008); this includes creating “expectations and boundaries” (Peterson et. al., 2010). These expectations and collaborations shape the coach’s identity; four types of identity have been noted: the coach as a supporter of teachers, the coach as a supporter of students, the coach as a learner, and the coach as a supporter of the school (Chval et al., 2010). Showers (1985) assigned functions to the role of a coach:

- 1) provide companionship,
- 2) provide technical feedback,
- 3) analyze application,
- 4) adapt the results to students

There are two specific roles for a coach: student achievement and supporting teacher growth and development (Staub, et al., 2003).

The most common tasks that coaches perform are to assist the teacher in professional development. Professional development is more effective if there is transfer

support (Guskey, 1986). Coaching acts as a form of transfer support (Joyce & Showers, 2002; Winton, McCollum, & Catlett, 1997). Staub, et al. (2003) identified these tasks: pre-lesson conferences, observations, teaching, co-teaching, and post-lesson conferences; Costa and Garmston (2002) identify three types of conversations: planning, reflecting, and problem solving. The key to these tasks are the conversations involved (Knight, 2011). Dialogue about “the what, the how, and the why” of instruction builds pedagogical content knowledge (Staub, et al., 2003) and becomes more meaningful and creative when the conversation contains active listening and not just a one-way conversation (Knight, 2011). The key to effective conversations are the questions that the coach asks to the coachee (Bearwald, 2011; Costa & Garmston, 2002; Maxwell, 2008; Sherris, 2010; Staub, West, & Bickle, 2003) and paraphrasing (Costa & Garmston, 2002; NBPTS, 2008; Sherris, 2010; Staub, West, & Bickle, 2003). Within these tasks coaches assume different support functions: consultant, collaborator, and (Costa & Garmston, 2002).

Knowledge of a Coach

A coach must possess a knowledge base that aligns with the responsibilities of the job. A coach’s knowledge stems from experience, professional development, and performance from time spent as a teacher. Coaches should demonstrate “mastery of pedagogical skills, content knowledge, and teaching experience” (NYSED, 2008, p.3). Table 2 identifies the types of knowledge that coaches need as outlined in the literature. Content knowledge is crucial in order to help others process students’ thinking and misconceptions (Bowman & Feger, 2006; Obara, 2010; Saphier & West, 2010). Pedagogical content knowledge is important in supporting teachers; coaches must be able to support teachers with knowledge of research and best practices; content knowledge

about mathematics is critical for a mathematics coach (Obara & Sloan, 2009; Obara, 2010; Saphier & West, 2010).

Table 2

The Knowledge of a Coach Comparison

Saphier & West (2010)	Obara (2010)	Borman & Feger (2006)
Content knowledge	Content knowledge	Content specific knowledge
Pedagogical knowledge	Pedagogical knowledge	Strong intrapersonal skills
Change Theory	Curriculum	Sensitive communication skills
Interpersonal Skill	Students	Able to diagnose teacher needs
Long term visioning	Research	Students
Planning		

Coaches must stay current in practice and research in order to model and support teachers. Coaches should have a “good working knowledge of a repertoire of teaching methods, alternative modalities of learning, and styles of teaching and learning that affect student achievement” (Koki, 1998, p. 3). Knowledge of students is vital in our diverse society; students have a wide range of differences ranging from gifted to English Language Learners (Obara, 2010). Coaches must be able to provide guidance, understanding, and support in coaching teachers to handle and respond to this diversity (Obara, 2010). Such deep knowledge allows coaches to solve problems and provide strategies, ideas, and support in flexible ways. In a study of 88 coaches, Garza, Ramirez,

Jr., and Ovando (2009) found that the coaches “perceived their classroom experience, pedagogical knowledge, disposition, interpersonal proficiency, and conscientious listening as traits that would enhance a mentoring relationship” (p. 11).

Teacher candidates have varied skill sets and knowledge, and coaches must be able to provide pedagogical and content support that addresses their individual needs (Glickman, 1980). It also is important for coaches to be aware of participation and non-participation behaviors in which teacher candidates either feel a part of the teacher profession or they are outside of the teacher profession (Wenger, 1998). Through coaching conversations, teacher candidates can become more aware of their role in education. Because of the nature of the educational environment, coaches should also have access to many strategies and techniques to help teacher candidates meet the needs of diverse and sometimes challenged K-12 students.

According to the National Foundation for the Improvement of Education (1999) the process of selecting coaches should tap into these kinds of pedagogical knowledge and include professional competence and experience. Additionally, coaches should demonstrate mastery of the field (Janas, 1996; Obara, 2010), provide instructional support (Obara, 2010; Rowley, 1999), and embody professionalism. A coach should be the epitome of a professional by helping mold and support a beginning teacher (Koki, 1998). Such professionalism entails continued education and professional development in the pedagogical and content knowledge of the field (Obara, 2010). Related to this commitment to professional development, effective coaches have also been described as life-long learners (Rowley, 1999).

Disposition

Coaches especially need to be chosen according to their attitude and character (Staub et al., 2006). In order to foster professional growth and reflection, coaches should value those processes and be able to relate to a teacher intern's growth and development. This means that coaches must assess and challenge teachers' beliefs, attitudes, and knowledge (Staub, et al., 2006). Effective coaches must also be effective communicators (Koki, 1998; Rowley, 1999; Staub, et al., 2003) with strong interpersonal skills (Koki, 1998 NYSED, 2008).

Communication—especially through constructive criticism, consultation, and emotional connectedness—is vital to the coaching process. Being able to interpret body language and understand responses are key skills of effective communication and meeting the needs of the teacher candidate. An accomplished coach must apply “certain well-crafted verbal and nonverbal tools to facilitate others' cognitive growth” (Costa & Garmston, 2002).

DuFour (2004) argued that, in order to maintain their connection with their profession, effective coaches must engage others with their hearts and know how to unite others to share their hopes and desires. When coaches develop a strong, communicative relationship with teacher candidates, they share in successes and failures as their own. Coaches maintain a reflective practice; they analyze and evaluate the process, progress, and next steps (Peterson, et al., 2010). Coaches who make a difference also celebrate successes small and large and work to create a collaborative atmosphere; this is an investment in the developing teacher (Young, et al., 2005). The coach maintains flexibility by adjusting to the beliefs, knowledge, and skills of the teacher. This is not a

relationship based on friendship (Peterson, et al., 2010), but should be more business-like and focused on the goal of the relationship (Veenman & Denessen, 2001). The goal of mathematics coaching is teacher growth and development, as well as, student achievement.

Commitment

The literature on coaching (Dagenais, 1996; DuFour, 2004; Janas, 1996; Koki, 1998.; Rowley, 1999) indicates that coaches should feel a moral obligation to the field of education. Coaches must possess the commitment of devotion to another's professional development (Young, et al., 2005). In order to support and guide others, coaches must be established in the profession. A good coach has been described by DuFour (2004) as a teacher leader. "Leaders must focus and accept responsibility for results" (p. 1). Coaches demonstrate responsibility by adhering to the guidelines and procedures set by the induction program and by valuing the role that they have accepted. By creating time to meet and assist the intern, coaches demonstrate dedication to the coaching relationship (Janas, 1996).

Professional Development for Coaches

The professional development of coaches is critical to the success of the coaching relationship (Charalambous, Philippou, & Kyriakides, 2008). Veenman and Denessen (2001) found that a coach who had received professional development rated higher than an untrained coach. Coaches need professional development before the mentoring process begins, in addition to support and follow-up throughout the coaching year, (Ganser, 1997; Obara, 2010; Saphier & West, 2010; Young et al., 2005). This professional development should consist of skills and methods in the areas of coaching

(Gordon & Brobeck, 2010), content knowledge, and curriculum (Obara, 2010).

Professional development should include questioning strategies, observation approaches, documentation, conferencing, and relationship building; all are which practices of being a coach (Obara, 2010).

Additionally, coaches must be prepared to handle the unexpected. Some teacher candidates have less education and preparation than others. While some come with effective classroom management strategies, skills for instructional planning, and a professional working ethic, some do not. Some candidates need more than the typical support. Some coaches are faced with resistance; others are faced with very dependent teacher candidates. According to Martinez (2004), there are “no magic wands to transform the impossible teaching contexts” that teacher candidates’ encounter (p. 5). Coaching professional development and practice should prepare mentors for these types of difficult coaching situations. “To optimize the benefits of coaching, coaches should be familiar with what is already known about teacher development, stages of teacher growth, and the predictable needs of beginning teachers” (Ganser, 1997, p. 8). It is clear that coaches need professional development in order to effectively work with teacher candidates. Another type of professional development that coaches benefit from is meeting weekly with their peers to share and learn from one another (Saphier & West, 2010). Coaching professional development is an important component of an induction program (Dagenais, 1992; 1996). Careful planning and development of coaching professional development is needed for a program to be effective in supporting teacher candidates.

Coaching Mathematics

Coaching mathematics teachers provides unique challenges. The literature on mathematics coaching is limited. The research advocates for mathematics coaches to have a specialized knowledge in the area of mathematics; some call this content specific coaching (Staub, et al., 2003). Sometimes referred as mathematics specialists, these coaches or specialists should have an intense understanding of mathematics, experience collaborating and teaching others about mathematics, and capable of providing the necessary K-12 student supports (Staub, et al., 2003). An increase in student achievement has been tied to the use of mathematics specialist (Gerretson, Bosnick, and Schofield (2008). Content specific coaching requires the use of specialized strategies for working with teachers (Staub, et al., 2003). Teachers who have had mathematics coaches are more likely to change their teaching practice (Race, Ho, & Bower, 2001) and focus on conceptual understanding (Campbell, 1996). These changes in teaching include diminishing the reliance on skill-based instruction and looking instead to the central ideas of mathematics and using an inquiry based methodology (Becker, 2001).

The pre-lesson conference, observation, co-teaching, and the post lesson conference are four tasks that coaches conduct to help facilitate professional development (Staub, et al., 2003). The essential piece of these strategies is the dialogue that takes place; the dialogue should center around the what, how, and why of lessons (Staub, et al., 2003). The key to coaching mathematics is to induce “pedagogical curiosity” that fosters a teacher’s evolution (Olson & Barrett, 2004), and that is accomplished through conversations (Staub, et al., 2003). There is a list of the important topics in mathematics planning. Staub et al., (2003) provide these core issues:

- Lesson goals
- Lesson plan and design
- Students relevant prior knowledge
- Relationship between the nature of the task and the activity and lesson goals
- Strategies for students to make public their thinking and understanding
- Evidence of students' understanding and learning
- Students' difficulties, confusions, and misconceptions
- Ways to encourage collaboration in an atmosphere of mutual respect
- Strategies to foster relevant student discussion

These issues get to the heart of mathematics design. They provide support to assist mathematics coaches in planning and having conversations to push the thinking of teacher. Figure 5 provides a guide for these central elements in mathematics lesson design by providing sample questions for the coach. This is a guide to provide support for coaches and not meant to be used as a structured model (Staub, et al., 2003).

Figure 5

Guide to Core Issues in Mathematics Lesson Design

What are the goals and the overall plan of the lesson?

- What is your plan?
 - Where in your plan would you like some assistance?
- (Based on the teacher's response, the coach focuses on one or more of the following ideas.)

What is the mathematics in this lesson? (i.e., make the lesson goals explicit)

- What is the specific mathematics goal in this lesson?
- What are the mathematics concepts?
- Are there specific strategies being developed? Explain.
- What skills (applications, practice) are being taught in this lesson?
- What tools are needed (e.g., calculators, rulers, protractors, pattern blocks, cubes)?

Where does this lesson fall in the unit and why? (i.e., clarify the relationship between the lesson, the curriculum, and the standards)

- Do any of these concepts and /or skills get addressed at other points in the unit?
- Which goal is your priority for this lesson?
- What does this lesson have to do with the concept you have identified as our primary goal?
- Which standards does this particular lesson address?

What are students' prior knowledge and difficulties?

- What relevant concepts have already been explored with this class?
- What strategies does this lesson build on?
- What relevant contexts (money, for example) could you draw on in relation to this concept?
- What can you identify or predict students may find difficult or confusing or have misconceptions about?
- What ideas might students begin to express and what language might they use?

How does the lesson help students reach the goals? (i.e., think through the implementation of the lesson)

- What grouping structure will you use and why?
 - What opening question do you have in mind?
 - How do you plan to present the tasks or problems?
 - What model, manipulative, or visual will you use?
 - What activities will move students toward the stated goals?
 - In what ways will students make their mathematical thinking and understanding public?
 - What will the students say or do that will demonstrate their learning?
 - How will you ensure that students are talking with and listening to one another about important mathematics in an atmosphere of mutual respect?
 - How will you ensure that the ideas being grappled with will be highlighted and clarified?
 - How do you plan to assist those students who you predict will have difficulties?
 - What extensions or challenges will you provide for students who are ready for them?
 - How much time do you predict will be needed for each part of the lesson?
-

(Staub et al., 2003)

In mathematics coaching, questioning and providing feedback influence teacher candidates' beliefs (Charalambous, Philippou & Kyriakides, 2008). Obara and Sloan

(2009) found that the support of a coach as long term professional development does have an impact on changing teacher beliefs.

Challenges with Coaching

The coaching of others has its challenges. When coaches are not prepared for dialogue of coaching, the support is hindered (Gordon & Brobeck, 2010). Some coaches have difficulty adapting to the various needs of the coachee (Gordon & Brobeck, 2010); this hinders rapport between the coach and the coachee. This problem clearly means that coaches need training in order to do their job effectively (Gordon & Brobeck, 2010; McCann & Johannessen, 2008). Another problem is when the relationship only focuses on the logistics and does not get at the heart of instructional change (Gordon & Brobeck, 2010).

A new perspective offers that the relationship depends on the teacher being coached. Yopp et al., (2011) found that the teachers need to be “consumers of coaching” in order for it to be the effective. This means that the teachers have roles and responsibilities within the coaching relationship. Yopp et al., (2011) identified six teacher behaviors that are necessary for effective coaching.

1. Teachers request targeted feedback from their coach.
2. Teachers participate in deep reflection and are open to the reflective process.
3. Teachers clearly state their needs to the coach.
4. Teachers clearly state their expectations about the coaching relationship. This includes the level of interaction.
5. Teachers must be open to analyzing their own content knowledge.

6. Teachers must be willing to participate and seek the scheduling of a pre-lesson conference, lesson observation, and a post-lesson conference.

Implications of Coaching.

Coaching has its benefits. Identified as an effective type of professional development, coaching increases the likelihood of the implementation of new initiatives and curricular changes. McGatha's (2008) case study of two coaches revealed that coaching does create a climate for instructional change. These changes include focusing on inquiry/ problem based instruction (Race, Ho, & Bower, 2001), building conceptual understanding (Campbell, 1996), and focusing on the big ideas of mathematics (Becker, 2001). Other changes in the teaching methods included adding dialogue among and between students about their thinking (McGatha, 2008).

Coaching is an important form of professional development for teachers (Bell, Grant, & Fisk-Moody, 2007). Chval et al., (2010) recognized these benefits of coaching:

- The implementation of new instructional strategies
- Sustaining high-quality practices
- Increased collegiality
- Increased teacher reflection
- Improvement in student achievement

Coaching of first year teachers helps to increase their confidence, resilience, and advocacy (He, 2009). It also leads to validation and solidification of their identity as teachers (He, 2009; Bell, et al., 2007). Effective coaching is the result of a long-term commitment and not a short-term fix (Campbell, 2009; Knight, 2009).

In order for coaches to make a difference, there are some things to be considered. The selection of a coach needs to be based on knowledge and dispositional criteria. Coaches need to have a commitment to their profession. It is also important to provide coaches with the training and support needed to evoke instructional change.

Teacher Candidates' Beliefs and Attitudes

Teacher candidates' beliefs and attitudes have been studied extensively and seem to influence the instructional decisions that teachers make in their classroom (Beswick, 2006; Karp 1988; Pajares, 1992). In *Beliefs and Attitudes in Mathematics Education*, Maaß and Schlöglmann (2009) stated:

Prospective teachers undertaking university education bring with them beliefs and attitudes towards teaching acquired during their years as students at school. These beliefs can be a barrier to developing new teaching competencies – we should therefore find out more about these beliefs. (p. ix)

The teaching of mathematics is a complex endeavor that is influenced by three elements: the teacher's system of beliefs, the social context, and the teacher's level of thinking and reflection (Ernest, 1989). There are several aspects of beliefs that need to be considered for this literature review; these include differentiating between beliefs and attitudes, epistemological beliefs, and beliefs about teaching. Last, a look at the impact of teacher preparation on changing beliefs will be discussed.

Beliefs and Attitudes

Often beliefs and attitudes get lumped together as one entity. However, there are differences that must be identified. McLeod (1992) identified attitudes as positive or

negative emotional reactions that can be fairly powerful and durable. The development of an attitude stems from two possibilities: the repetition of an emotional response or a current attitude is transferred to different task that provides a new perspective (Pehkonen & Pietilä, 2003). This means that attitudes are outwardly portrayed to others.

Beliefs are deeper and are not as easy to recognize as attitudes. Beliefs are defined as a person's "subjective, experience-based, often implicit knowledge and emotions on some matter or state of art" (Pehkonen & Pietilä, 2003, p. 2). In order to prepare for the assessment of beliefs, Ambrose et al. (2003) categorized four components of beliefs after analyzing the literature for common themes; they are identified in Table 3.

Table 3

Four Components of Beliefs

Belief Component	Cited reference
Beliefs influence perception.	Pajares, 1992
Beliefs are held with varying intensities.	Pajares 1992; Rokeach, 1968
Beliefs are context specific.	Cooney, Shealey, & Arvold, 1998
Beliefs are dispositions toward action.	Cooney, Shealey, & Arvold, 1998
Ambrose et al. (2003)	

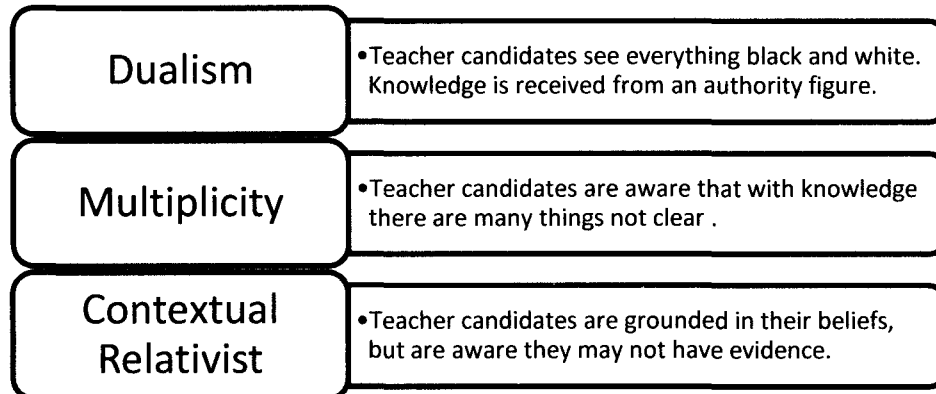
By identifying these components, beliefs can be analyzed and targeted. Fives and Buehl (2008) identified an initial framework with four components: beliefs about the importance of teacher knowledge, beliefs about the ability to teach, beliefs about

teachers' need for cognitive skills and abilities, and beliefs about teachers need for affective qualities. Both of these sets of components allow for specific analysis.

Epistemological Beliefs. Epistemology is the theory of knowledge, thus epistemological beliefs are those related to the beliefs about knowledge and learning. The first study of epistemological beliefs was by William G. Perry in 1970; he identified a progression of development based on personal epistemological growth in college students. He found it to be one-dimensional within these nine set stages which he grouped into four clusters: dualism, early multiplicity, late multiplicity, and contextual relativism. The clusters are defined in Figure 6.

Figure 6

Perry's Belief Clusters



(Perry, 1970)

While Perry found epistemological beliefs to be one-dimensional, others find them to be multidimensional. One-dimensional theorists believe these stages are based on cognitive development. This means that teacher candidates do not have to go through all stages. Multi-dimensional theorist believe that teacher candidates can be stuck in one of these categories and not necessarily experience all of them (Yilmaz-Tuzun & Topcu, 2008).

Beliefs about Teaching

Ideas about what it means to teach are embedded in the minds of students after spending thirteen years going to school. This experience was labeled as “the apprenticeship of observation” by Lortie (1975). The experience of being a student is connected to the beliefs that one holds about the role of the teacher and how to teach. Beliefs about teaching and learning are often developed long before students enter college (Kagan, 1992; Nosich, 2009; Stuart & Thurlow, 2000); Murphy et al. (2004) discovered that these beliefs are formed as early as the second grade and were found to be similar to teacher candidates. The longer the belief is held the more difficult it is to change (Pajares, 1992), so beliefs that begin in second grade are deeply rooted. Teacher candidates that experience anxiety with mathematics often have negative beliefs about mathematics (Swars, Daane, & Gliesen, 2006). These negative beliefs lead to traditional, less engaging teaching, and lower student achievement (Kolstad & Hughes, 1994).

Nosich (2009) labels these attitudes and beliefs as background stories and concludes that they are almost impossible to alter (Pajares, 1992). These stories are explained partially why teachers tend to teach mathematics the way that they were taught. These background stories need to be explicitly challenged and checked in order for learning to truly take place. Teacher candidates must bring their beliefs to a “conscious level” in order to analyze and challenge them; without this consciousness traditional teaching practices will continue to be the norm (Stuart & Thurlow, 2000). Teacher candidates’ beliefs help determine what they will retain during course work (Fives & Buehl, 2008). If they don’t believe in the significance of the content, they learn less (Fives & Buehl, 2008). In addition, when teacher candidates are faced with situations and

content that challenges their beliefs, they begin to question their competence (Fives & Buehl, 2008).

Teacher candidates' beliefs and practices can be impacted by the teacher preparation program (Kasten & Buckley von Hoek, 2008). Teacher candidates can move toward a student centered philosophy during the course of their program (Kasten & Buckley von Hoek, 2008). This was determined with a longitudinal study over four years involving 2365 teacher candidates. In a yearlong study with five interns, Bates and Rosaen (2010) found that the teacher program helped to change beliefs regarding students. They found that teacher candidates expanded their beliefs of teaching and learning to focus on individual needs. Another study by Bonner and Chen (2009) found that teacher candidates' beliefs about grading changed following their course work. They moved from very traditional beliefs about using grading to influence behavior to a moderate belief of accepting non-traditional forms of assessment (Bonner & Chen, 2009). Beliefs affect all aspects of teaching (Pajares, 1992).

Barlow and Cates (2006) found that through the implementation of problem solving and problem posing questions that teachers' beliefs about the teaching of mathematics changed from a traditional perspective to that of a constructivist one. The beliefs that teachers held about students, assessment, and student centered instruction all changed through the instructional change of adding these inquiry based strategies (Barlow and Cates, 2006).

Beliefs about Mathematics

Content knowledge is also affected by teachers' beliefs. Mathematics is no exception; in fact it is one content area where beliefs become the most detrimental. "Teacher candidates are under the misconception that teaching mathematics in an elementary classroom is easy because they believe that they have mastered elementary school mathematics concepts" (Patton, Fry, Klages, 2008, p.487). It has also been noted that individuals typically drawn to teach elementary school are not the people with strong mathematical content knowledge and expertise (Philippou & Christou, 1998). This makes them unprepared to teach mathematics as they believe they can handle the teaching of elementary mathematics because it is less intimidating (Ma, 1999).

In 1989, the National Council of Teachers of Mathematics (NCTM) released standards to establish expectations for mathematics teaching; yet the norm still involves traditional teaching of mathematics based on procedures and skills (Ball, et al., 2001; Pajares, 1992; Saul, et al., 2010). Teachers' beliefs are connected to the experience that they had as students in mathematics classrooms (Cady & Rearden, 2007); these situations were often teacher centered and not focused on conceptual understanding. This places extreme importance on the mathematics teacher (Cady & Rearden, 2007) which in turn places the responsibility on teacher education programs and the mathematics educator.

There is a naïve notion among teacher candidates that teaching elementary mathematics consists of presenting facts and making sure that students memorize the procedures (Patton, et al., 2008). "To meet the challenge to reform mathematics education, effective opportunities to learn are needed to promote prospective elementary school teachers' development of the knowledge base that supports teaching for

mathematical proficiency” (Timmerman, 2004, p. 369). Teacher candidates need to be able to understand student thinking and misconceptions in order to help students understand mathematics (Ball, et al., 2001; Patton, Fry, & Klages, 2008).

The role of being a student helps perpetuate beliefs about mathematics. Teacher candidates tend to see themselves as students and not as part of the profession (Hart, 2002; Nosich, 2009). Many simply go through the motions, crossing off tasks and assignments, and not seeing the work of the program as part of their professional development of becoming a teacher. These beliefs also mean that they do not believe that they can make changes to the instruction. Some of their beliefs are contradictory to other beliefs that they hold; these teacher candidates are unaware of these opposing views (Beswick, 2006). In order for teacher candidates to deviate from the traditional methods of teaching mathematics their beliefs have to be identified and examined (Stuart & Thurlow, 2000). This process requires reflection, and their background stories become part of future decision making. A personal connection between the methods must be made as they are learning and their image of their future classroom must be formed in order to challenge their beliefs (Stuart & Thurlow, 2000) and help them to internalize the methods, strategies and expectations of the methods courses. In order to challenge beliefs about mathematics, teachers and teacher candidates need to experience new situations in which they have to think differently (Smith, 2001). Through reflection and analysis of the new situation, beliefs are confronted (Smith, 2001).

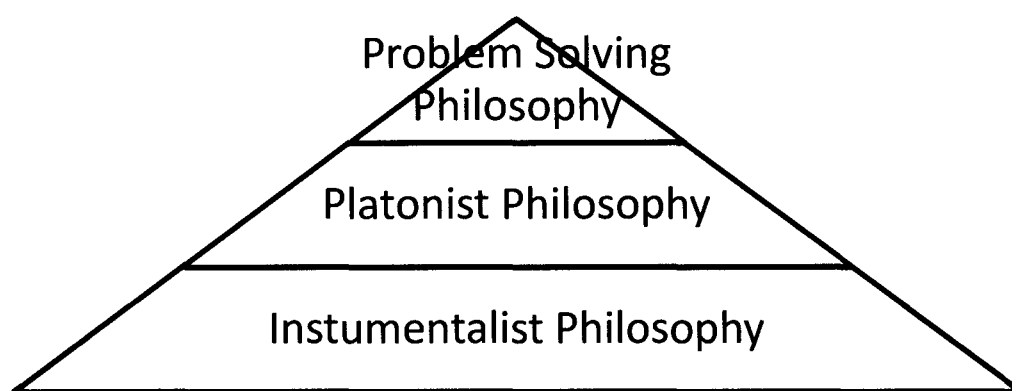
Ernest (1989) identified the mathematics teachers’ schema concerning beliefs; this schema contains three components: conception of the nature of mathematics, view of the nature of mathematics teaching, and the view of the process of learning mathematics.

This complex schema makes up teachers' philosophy of mathematics (Ernst, 1989).

Three philosophies of mathematics have been identified: the instrumentalist view, the Platonist view, and the problem solving view (Ernest, 1989; Thompson, 1984). These three philosophies fit into a hierarchy found in Figure 7.

Figure 7

Hierarchy of Mathematics Philosophies



(Ernest, 1989; Thompson, 1984)

The instrumentalist philosophy rests on the belief of procedural based mathematics that includes unrelated and utilitarian rules and facts (Ernest, 1989). This belief is prevalent amongst teacher candidates (Ma, 1999; Saul, Assouline & Sheffield, 2010). The Platonist philosophy believes that mathematics is discovered, it is static, and is a unified body of certain knowledge (Ernest, 1989). The problem solving philosophy believes mathematics is dynamic, a process of inquiry, and a continually expanding field (Ernest, 1989). This philosophy is one matched in the reform-based mathematics movement. NCTM identifies the characteristics of high quality mathematics instruction:

- The choice of problems that invite exploration of a concept

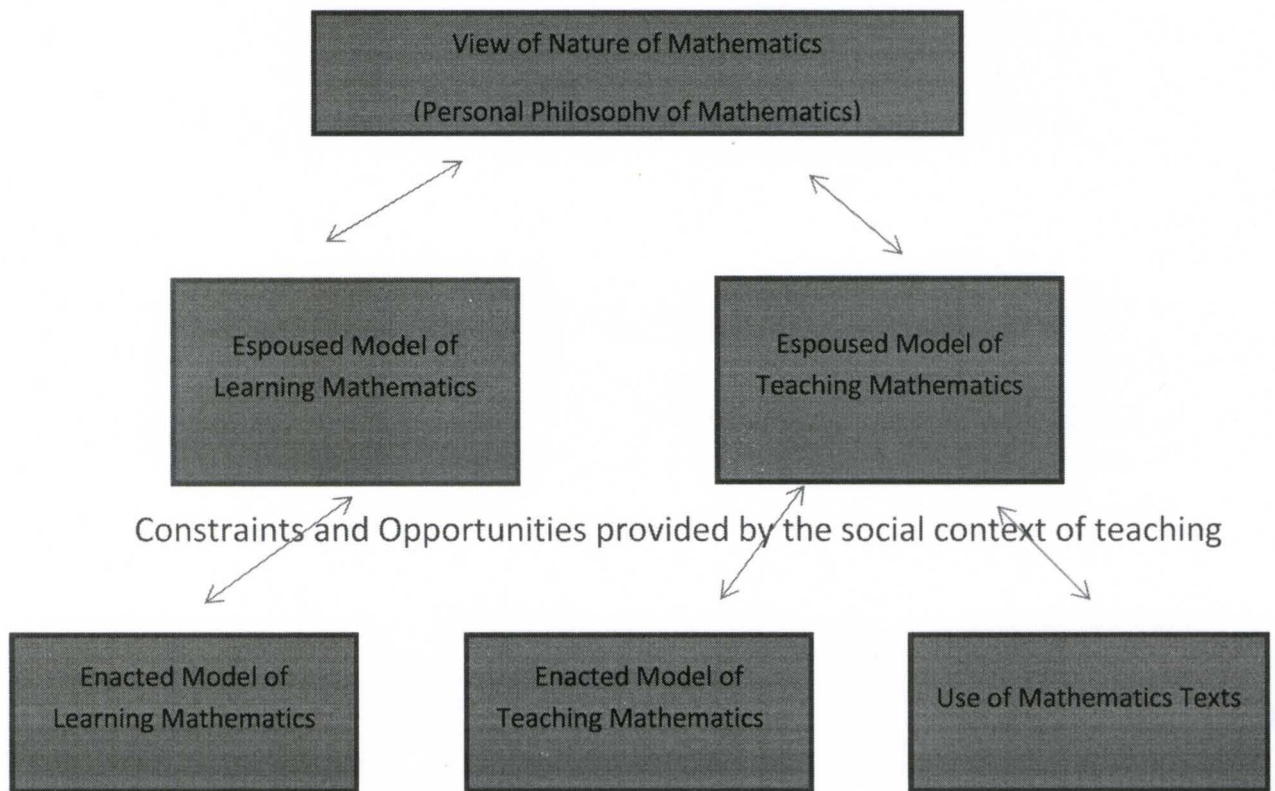
- Allow students to solidify and extend knowledge
- Assess through discussions and ask students to justify their answers
- Use questioning techniques to facilitate learning
- Encourage multiple solutions
- Challenge students to think
- Create opportunities for students to communicate mathematically
- Model appropriate mathematical language

(NCTM, 2003/2006)

These elements should be common place in all mathematics classrooms. This means that teachers must be prepared to incorporate the elements into their practice which is more complex and requires a deeper understanding of mathematics. Ernest (1989) created a visual depicting how a teacher's mathematical philosophy has an impact on the teaching practice (see Figure 8). This model displays how the teacher candidates' mathematical philosophy affects how mathematics is learned and taught. It also displays how these beliefs impact the choice in mathematics textbooks and supplies, as well as what type of mathematics is promoted.

Figure 8

The Relationship between Beliefs and their Impact on Practice



(Ernst, 1989)

A teacher candidate can articulate a problem solving philosophy, however when actually teaching implement a very instrumentalist philosophy (Nathan & Koedinger, 2000).

These beliefs are deeply rooted and can blind the teacher candidate of the disconnect in their philosophy and practice. Ball (1988) created this list of commonly held mistaken beliefs based on research and experience:

- Mathematics does not have much relationship to the real world and most mathematical ideas cannot be represented any way other than abstractly, with symbols.

- Knowing mathematics means "knowing how to do it."
- Teaching mathematics involves telling (or showing) the students how to do different kinds of problems.
- Teachers ask questions to elicit right answers; if a teacher questions your answer, it means you have made a mistake.
- Learning mathematics is scary.
- Good teachers make mathematics *fun* for students.
- Elementary school mathematics teaching does not require much knowledge of math—anyone who can add, subtract, multiply, and divide knows enough mathematics to teach little kids. Learning to teach, therefore, is mainly a matter of acquiring techniques.
- Love of children, not knowledge of subject matter, is the basis of elementary school teaching.
- Young children are trusting and eager to learn but are not yet capable of thinking about complicated mathematical ideas or solving real problems.

(p. 44)

These beliefs are misconceptions that many teacher candidates have about mathematics. In contrast, Ambrose et al. (2004) identified seven accurate beliefs that fit into three categories provided in Figure 9. They developed this list in order to target and classify beliefs held by teachers and teacher candidates. These beliefs are the ones that they used to develop their beliefs instrument.

Figure 9

List of Seven Accurate Beliefs about Mathematics

Beliefs about Mathematics

Belief 1. Mathematics, including school mathematics, is a web of interrelated concepts and procedures.

Beliefs About Knowing/Learning Mathematics

Belief 2. One's knowledge of how to apply mathematical procedures does not necessarily growth understanding the underlying concepts. That is, students or adults may know a procedure they do not understand.

Belief 3. Understanding mathematical concepts is more powerful and more generative than remembering mathematical procedures.

Belief 4. If students learn mathematical concepts before they learn procedures, they are more likely to understand the procedures when they learn them. If they learn the procedures first, they are less likely ever to learn the concepts.

Beliefs About Children's [Students'] Doing and Learning Mathematics

Belief 5. Children can solve problems in novel ways before being taught how to solve Such problems. Children in primary grades generally understand more mathematics and have more flexible solution strategies than their teachers, or even their parents, expect.

Belief 6. The ways children think about mathematics are generally different from the ways adults would expect them to think about mathematics. For example, real-world contexts support children's initial thinking whereas symbols do not.

Belief 7. During interactions related to the learning of mathematics, the teacher should allow the children to do as much of the thinking as possible.

(Ambrose, Clement, Philipp, & Chauvot, 2004)

Teacher candidates can have positive, accurate beliefs about mathematics (Ball, 1988). This means that not all beliefs need to be addressed and challenged; these beliefs need to be extended and flushed out to increase teacher candidates' understanding and success (Ball, 1988). These beliefs and views have effects on teaching. Traditional beliefs

about the teaching and learning of mathematics are prevalent amongst teachers and teacher candidates (Kolstad & Hughes, 1994; Ma, 1999).

Beliefs are clearly tied to the teaching practice. Conducting teacher effects research, Brophy (1987) found that ineffective mathematics teachers used ineffective practices and were dependent on other sources for instruction. Their teaching practice was dependent on individual, passive learning practices that don't yield high gains in student achievement (Brophy, 1987). Effective teachers have a strong content knowledge base and are skilled in pedagogical practices. They also have knowledge of their students' strengths and areas of growth (Brophy, 1987). Gage (1984) credits the instructional practice as the key to successful learning. This research on teacher effects mirrors the research on teacher beliefs and raise questions and concerns for the implications on teacher education. Staub and Stern (2002) found that third graders' had lower achievement levels when their teacher held traditional views of teaching mathematics. Teachers who held to constructivist beliefs had third graders who had higher achievement. Bray (2011) found that beliefs impacted the type of conversations and dialogue that teachers had with students about errors and misconceptions. She found that teacher knowledge determined the "quality" of the conversations, but the beliefs determined how these conversations were handled. Teachers need more knowledge and experience with students' misconceptions in order to know how to address them in class (Bray, 2011).

Mathematics educators need to know these beliefs and decipher which beliefs are problematic and which ones need to be solidified into effective mathematics teaching (Ball, 1988). "To improve mathematics education for all [mathematics educators] need to

expand teaching practices that engage and motivate students as they struggle with their own learning” (NRC, 1989, p. 57). Wilkins and Ma (2003) urge teachers to be advocates for change; by example teachers can help to create positive experiences and create positive feelings and beliefs about mathematics.

Impact of Teacher Preparation on Beliefs

Teacher candidates’ beliefs about mathematics are an important factor to consider when examining teacher education programs (Bray, 2011; Kolstad & Hughes, 1994; Timmerman, 2010). Their beliefs are at the heart of creating instructional change (Fives & Buehl, 2008; Leavy, McSorley & Boté, 2007). Teacher preparation is a key element in examining, challenging and changing the beliefs of future teachers (Leavy, McSorley, & Boté, 2007; Ng, et al., 2007). To best facilitate the growth and progress of teacher candidates, teacher educators must focus on understanding the beliefs of teacher candidates (Fives & Buehl, 2008). It is the responsibility of teacher educators to create an atmosphere where teacher candidates identify, reflect, and analyze their beliefs (Reeder, et al, 2009, citing Dewey, 1933, 1965).

This is a difficult task. Often these beliefs and attitudes are stronger than the methods presented in their courses and those they see in the field (Nosich, 2009); this means that beliefs and attitudes provide a stronger basis for instructional decisions than the teaching done in their courses. The teacher candidates’ beliefs determine what is learned and internalized from the course work (Fives & Buehl, 2008). In response, teacher education courses must be designed around the examination and challenge of teacher candidates’ beliefs, especially in the area of mathematics (Timmerman, 2010; van

der Sandt, 2007). The courses, especially mathematics methods courses need to help teacher candidates identify their beliefs and analyze the effects that they could have on students (Bray; 2011; van der Sandt, 2007). Teacher education programs have been found to increase student-centered instructional practices and beliefs (Kasten & Buckley von Hack, 2008).

There are few studies that have examined the impact of the teacher preparation program on teacher candidate's beliefs. Brownlee (2004) found that teacher candidates' demonstrated an increase in the epistemological beliefs that were more sophisticated at the end of the teacher program compared to the beginning of the program. She conducted a qualitative study of 29 teacher candidates that included interviews and reflections. While she found results in changing beliefs through a teacher preparation program, she also acknowledged that other causes could not be ruled out like the addition of another course or life experiences, and urged for more research. In a study of 200 teacher candidates, their beliefs about teaching and learning in a mathematics classroom remained stagnant resulting in a conclusion that the teacher preparation program was not effective changing belief systems (Reeder, et al, 2009). In contrast, Philipp et al. (2007) found that the mathematics methods course does impact a change in teacher candidates' beliefs. The mathematics course coupled with analysis of student thinking about mathematics saw more dramatic changes in teacher candidates' beliefs (Philipp et al., 2007).

Chai, Teo, and Lee (2009) conducted a quantitative study of 413 teacher candidates in Singapore. They found that the teacher preparation program led to an increase in two epistemological beliefs: certainty of knowledge and authority/expert as a

source of knowledge. This finding seemed logical as teacher candidates furthered their application of applying their knowledge in teaching and built their self confidence in teaching (Chai, Teo, & Lee, 2009). They also found an increase in the belief of traditional teaching that they attributed to the multifaceted work of a teacher or high stakes accountability. The pressure creates an atmosphere to control thus leading in more traditional teaching practices.

Ng, Nicholas, and Williams (2007) examined the effects of the field placement on changing teacher candidates' beliefs. The belief that teachers' dispositions should be kind, caring, understanding, and personable remained constant (Ng, et al., 2007). Beliefs about good teaching changed over time from being concerned about control to loss of self-control and ending with giving students more control. Beliefs about student achievement had the most variability over the course of the field experiences looking at their beliefs before field placements began and at the after the completion (Ng, et al., 2007). Often it is the internal or external locus of control beliefs that cause problems for teacher candidates (Cady & Rearden, 2007). This means that teacher candidates are stuck viewing teachers as the holders of knowledge, failing to develop an internal locus of control (Cady and Rearden, 2007; Perry 1970).

Research has identified key techniques that are effective in challenging and evoking change in teacher candidates' beliefs. Authentic, research based activities will require teacher candidates to make changes in beliefs and practices (Lee & Herner-Patnode, 2010). These activities include assignments based on students living in poverty, and strategies to guide reflection (Lee & Herner-Patnode, 2010). Leavy, McSorley, and Boté (2007) found that the use of metaphors in class discussions was a useful mechanism

for identifying, reflecting, and changing teacher beliefs, while Jones and Vesilind (1996) used concept mapping as a tool to assess and compare beliefs over a semester. Other strategies include a reflective journal, peer teaching, and interviews; these were found effective for promoting change in mathematics (Timmerman, 2010). Other aspects of the teacher education program can also influence teacher beliefs. The curriculum materials available for teacher candidates are important (Chai, Teo, & Lee, 2009). It has also been noted that ten weeks or a semester is not long enough to cause a shift or change in beliefs (Chai, Teo, & Lee, 2009).

Pajares (1992) has been the only researcher to identify clear steps when working to change beliefs. His four suggestions have been applied to teacher candidates. They are listed below:

- 1) Teacher candidates must recognize that new learning can cause discomfort.
- 2) Teacher candidates must see the new learning has to be merged with their current beliefs.
- 3) Teacher candidates must want clarity between the new information and their beliefs.
- 4) Teacher candidates must realize that combining the new information and their beliefs won't work.

Schools of education have struggled with how to define, identify, monitor, and address beliefs and attitudes of teacher candidates (Shiveley & Misco, 2010). This problem falls under NCATE's term and expectation of dispositions (Shiveley & Misco, 2010). Schools of education are expected to address dispositions within their admissions

and throughout their programs in order to highlight the seriousness of dispositions in the teaching field as part of NCATE's Standard Three (NCATE, 2008). One way to monitor and examine dispositions of teacher candidates is the use of university supervisors in the field. Supervisors can serve as coaches providing support, feedback and fostering the reflective practice of the teacher candidates. The key to change in dispositions is "looking inside classroom lessons, plus the development of mathematical topics over time, helps to unearth the mathematical entailments of practice" (Ball, Lubienski, & Mewborn, 2001, p. 452). It is a disservice for teaching programs to merely offer instructional strategies and resources without "attending to their [teacher candidates] relevant beliefs" (Beswick, 2006, p. 21).

In conclusion, teacher candidates' beliefs are powerful and important. Beliefs cannot be ignored within teacher preparation programs and mathematics methods courses (van der Sandt, 2007). All those involved in the education and preparation need to help candidates identify, assess, and challenge these beliefs. This is a key process to moving teacher candidates into the teaching of reform based mathematics (Handal & Herrington, 2003).

Professional Development

Professional development is a critical topic of the current study and warranted an investigation of the literature. The current study hinges on the effects of professional development, so the experience has to be planned based on the research.

Planning the Professional Development

The literature is clear about the need for professional development to be meaningful and have a defined purpose and support (Guskey, 2000; Ingvarson, Meiers, &

Beavis, 2004; Joyce and Showers, 2002). Key characteristics of professional development have been identified to benefit professional development developers. One theme emerging from the literature is professional development must revolve around “problems of the practice” (Darling-Hammond & Ducommon, 1995, 1999; Mundry & Loucks-Horsley, 1999; Smith, 2001). This allows teachers to reflect and analyze their instructional practice; this is the key to creating a culture of change. In order to comply with this expectation, professional development activities should include mathematical task analysis and development, case study evaluations, and collaborative activities like lesson planning, assessment design (Smith, 2001; Stein, Smith, Henningsen, & Silver, 2009).

Another critical component is providing content based professional development (Desimone, et. Al, 2002; Garet, Porter, Desimone, Birman, & Yoon, 2001; Ingvarson, Meirs & Beavis, 2004; Smith, 2001). This allows teachers to utilize the general technique in something that is concrete to their practice. This creates an authentic learning experience. The content should also provide challenge and rigor in order to foster instructional change (Borko, 2003; Guskey, 2000; Hammond & Ducommon, 1999; Ingvarson, Meirs, & Beavis, 2004; Smith, 2001). Activities found in effective professional development include teachers doing mathematical tasks with multiple avenues for solutions (Smith, 2001; Stein, Smith, Henningsen, & Silver, 2009).

Other key characteristics that define quality professional development include being primarily focused on student achievement (Smith, 2001; Stein, Smith, Henningsen, & Silver, 2009), considerate of the adult learner (Darling-Hammond & Ducommon, 1995; Desimone et.al, 2002), and providing opportunities for collaboration and dialogue

(Darling-Hammond & Ducommon, 1995; Desimone, Porter, Garet, Yoon, & Birman, 2002; Joyce & Showers, 2002; Smith, 2001). Professional development should also be relevant with a defined purpose (Guskey, 2000; Joyce and Showers 2002; Ingvarson, Meiers, Beavis, 2004).

In order to put these characteristics into practice a model is necessary to organize and plan the design. Guskey (2000) identified several models for professional development. In order to increase the effectiveness of the professional development design combining them yields more success. Guskey's (2000) work will be used as a guide for choosing the features of implementation; he outlined the numerous forms of professional development:

- Training
- Observation/ assessment
- Involvement in the improvement process
- Study groups
- Inquiry/ action research
- Individually guided activities
- Mentoring

Training is the traditional whole group professional development. It includes a set topic, goals, and format. "Training is the most efficient and cost-effective professional development model..." (Guskey, 2000, p. 23). Observation/assessment is the act of collaborative analysis of teaching. Two or more teachers would team up and observe and analyze each other's teaching. Being involved in the improvement process is a type of

professional development that includes researching and working to address a need. This type of professional development creates ownership on part of the teacher. Study groups include a group of teachers researching or studying about an area of need. Collegial dialogue and reflection are at the heart of this type of professional development. Inquiry/ action research is more systematic than being involved in the improvement process or the study groups. There is a clear problem to be addressed, data to collect and organize, research to gather, and a plan to implement. Mentoring is the last type of professional development. This type pairs an inexperienced teacher or a teacher in need with an experienced or successful teacher. Their relationship, conversations, and reflections help foster instructional change. Guskey (2000) found that transference increased when professional development included multiple forms. The professional development designed for the university supervisors will be planned using Guskey's work; this is summarized in Table 4 and then described in detail below.

Table 4

Guskey's Framework & Current Study

Guskey (2000)	Current Study
Training of university supervisors	Coaching methodology Reform-based mathematics pedagogy The elements of the RTOP instrument NCTM process standards
Observation/ assessment	RTOP instrument Pre and Post assessments (MBI) Observations of both university supervisors and teacher candidates Interviews of university supervisors and a sampling of teacher candidates
Involvement with the improvement process	Goal setting
Study Groups	University supervisor monthly meetings
Inquiry/ Action Research	Questions and problem solving during monthly meetings
Individually Guided Activities	Based on goal setting and follow-up professional development sessions
Mentoring	Provided in monthly meetings

All university supervisors will attend professional development in the summer semester and two follow-up sessions during the fall semester 2011. The professional development will consist of instruction in the use of coaching, "best practices" in reform-based mathematics instruction, and using the RTOP. The NCTM process standards and the Common Core mathematical standards are also a part of this professional development. Table 5 displays the expectations set forth by these documents. They do overlap and provide tangible behaviors that are expected in mathematics classrooms.

Table 5

A Compilation of Reform-Based Mathematical Expectations

NCTM Process Standards	CCSS Mathematical Practices	RTOP Components
Problem Solving	1. Make sense of problems and persevere in solving them. 5. Use appropriate tools strategically.	-Student exploration -Alternative models of problem solving valued -Student predictions and investigation of their thinking
Reasoning and Proof	2. Reason abstractly and quantitatively. 3. Critique the reasoning of others. 8. Look for and express regularity in repeated reasoning	-Elements of abstraction encouraged - Reflective -Students use a variety of means to represent phenomena
Communication	3. Construct viable arguments	-Students communicate with a variety of means and media -Teacher questions trigger divergent modes of thinking -High proportion of student talk -Student questions and comments lead the direction of classroom discourse -Respect
Connections	6. Attend to precision. 7. Look for and make use of structure	-Connections with the real world and other disciplines -Value of student prior knowledge

Representations	4. Model with mathematics.	<ul style="list-style-type: none"> -Alternative modes of investigation -Elements of abstraction encouraged -Use of a variety of means to represent phenomena
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Summary

This literature review discussed the key elements of elementary teacher preparation with regard to mathematics as presented in Figure 1. These elements are all critical to the research questions for this study.

1. What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?
2. What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?

Teacher candidates enter the teacher program with firmly held beliefs about teaching (Kagan, 1992; Lortie, 1975; Nosich, 2009; Stuart & Thurlow, 2000), learning (Kagan, 1992; Lortie, 1975; Nosich, 2009; Stuart & Thurlow, 2000), and mathematics (Beswick, 2006; Patton, Fry, Klages, 2008). These beliefs impact the teacher practices of teacher candidates. Beliefs control the access for learning new information (Liljedahl, 2005). It is important for teacher preparation programs to address the beliefs of teacher candidates in order to stop the perpetuation of the long withstanding traditional views and teaching of

mathematics (Ball, 1988; Timmerman, 2004; Leavy, McSorley, & Boté, 2007; Bray, 2011). In 1989, it was clear that our country was in crisis in the teaching of mathematics, and the reform efforts began (NRC, 1989). NCTM (1989; 2000) clearly identified student centered teaching and learning based on constructivist thinking. The traditional views of procedures and memorization would no longer be good enough for our students to compete in the global society. Despite the reform, little has changed in the mathematics classrooms and more needs to be done (Ball, Lubenski, & Mewborn, 2001; Pajares, 1992).

For the purpose of this study, the cooperating teacher was not the focus as the change agent. The university supervisors as part of the field experience of teacher candidates are key (Blanton, Berenson & Norwood, 2001; Freidus, 2002; Frykholm, 1998; Laboskey & Richert, 2002) in providing the dialogue to facilitate reflection (Blanton et al., 2001; Fernandez & Erbilgin, 2009) and thus challenging the teacher candidates' beliefs. The university supervisor acts as a coach in the field (Slick, 1997) bridging theory and practice. The supervisor is the voice to make sense between the program's philosophy and expectations and the field placement's views and practices (Zeichner, 2002). Coaching has been identified as an effective method for professional development (Sailors & Shanklin, 2010) and has proven to be effective for university supervisors (Fernandez & Erbilgin, 2009; Smith & Souviney, 1997).

The present study is designed to fill in a gap in the literature to investigate the role university supervisors play in changing teacher candidates' beliefs about the teaching and learning of mathematics. By examining the effects of professional development, this

study will help provide research about the type of support university supervisors need to challenge teacher candidates' beliefs about mathematics.

CHAPTER III

METHODOLOGY

This study was a program evaluation of the impact of university supervisors' supporting role after receiving professional development in the areas of coaching and reform-based mathematics pedagogy within a clinical supervision model. The present study investigated the relationship between elementary university supervisors' support and teacher candidates' beliefs and abilities about mathematics teaching and learning.

Beliefs about the teaching and learning of mathematics are deeply rooted in the experience that teacher candidates had from their kindergarten year through high school graduation (Nosich, 2009; Kagan, 1992). The conditions needed to change these beliefs are complex. Due to this complexity a two-phased, mixed methods approach was designed.

This chapter includes a description of the research questions, design, population and sample, sampling plan, positionality, instrumentation, data collection, data analysis, limitations, validity threats, and reliability.

Research Questions

1. What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?

2. What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?

Design

A mixed methods design was chosen for this study in order to more fully capture the relationship and interactions between the university supervisors and the teacher candidates. Using both quantitative and qualitative data is important to the examination of the research questions; it allows the researcher “to draw from the strengths and minimize the weaknesses of both” the qualitative and quantitative data (Johnson & Onwuegbuzie, 2004).

Quantitative Data

The research design for the quantitative data is shown below. The NR represents a non-random sample. The O represents the measure, and the X represents the treatment. This quantitative data was used to test the hypotheses that the treatment of professional development will impact on the university supervisors' instructional support and thereby the teacher candidates' beliefs and teaching practices.

N R: O₁ X O₂

The pre-test represented by O₁ is the Mathematics Beliefs Instrument (MBI) and the background information. This was administered and collected prior to the treatment. After the treatment, quantitative data represented with O₂ was taken from observations by the university supervisors and the researcher using the RTOP instrument of teacher candidates teaching mathematics, coded data from observations of university supervisors

conferring with teacher candidates, coded data from interviews, and the MBI administered as a post test (see Table 6).

Table 6

Pre and Post Data

Subject	Pre-Treatment Data	Post Treatment Data
University supervisor	MBI	Observations of conferring
	Background information	Interviews
		MBI
Teacher Candidates	MBI	Observations of Teaching
	Background Information	Interviews
		MBI

Qualitative Data

Qualitative data is “the source of well-grounded, rich descriptions and explanations of processes in identifiable local contexts. With qualitative data one can preserve chronological flow, see precisely which events led to which consequences and derive fruitful explanations” (Miles & Huberman, 1994, p. 1). In order to explain the impact and relationship of the university supervisor and the teacher candidates and to triangulate the quantitative data, qualitative data are necessary in describing the experience. The qualitative data for this study included both interviews and observations. These data was collected from both the university supervisors and the teacher candidates.

To triangulate the quantitative data, interviews (semi-formal), observations of the teacher candidates teaching mathematics, and observations of the university supervisors' conferencing with teacher candidates using the RTOP was conducted focusing on the impact of the professional development or treatment.

For **Phase One** of the study, exploratory research was conducted in a pilot study order to gather baseline data for comparison. This was done in order to gain background information about nature of the research problem. This included the dynamics of the current program prior to introducing the treatment. Data was collected in the form of observations, interviews, and beginning and end of the semester questionnaires (pre & post assessments). To fully implement the treatment and establish research priorities for the second phase, the pilot study was essential to gather baseline data and accurately describe the context of the study.

Phase Two of the study utilized a quasi-experimental design (Shadish, Cook, & Campbell, 2002). The dependent variable was identified as teacher candidates' attitudes and beliefs. Professional development for the university supervisors was defined as the independent variable or treatment. Professional development provided to the university supervisors included coaching practices infused with research and pedagogy on reform-based mathematics instruction and the components and use of the Reformed Teaching Observation Protocol (RTOP, 2000, described in greater detail below).

To ensure that the research questions were answered, both quantitative and qualitative data was collected from different sources as shown in Table 7.

Table 7

Research Questions and Data

Research Question	Type of Data	Instrument
What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?	Quantitative	RTOP
	Qualitative/ Quantitative	Observations of university supervisors conferring
	Qualitative/ Quantitative	Interviews with university supervisors and teacher candidates
What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?	Quantitative	MBI
	Qualitative/ Quantitative	Observations of teacher candidates
	Qualitative/ Quantitative	Interviews with university supervisors and teacher candidates

Population & Sample

The setting for this study was a college of education at a large Midwestern public, urban research university. The college defines itself as having an urban mission and is dedicated to enhancing the intellectual, cultural, and economic development of diverse communities. In 2008-2009, there were 3,065 students enrolled and 776 degrees awarded in the college. The college, which is NCATE, state, and APA accredited and NASSM and

NSCA approved, offers 69 baccalaureate, Master's, and doctoral degree programs. The college ranks within the *US News and World Report's* Top 75 best graduate schools in education. This site was chosen because it is the largest teacher-training institution in the region; it is dedicated to the local school districts, and it is recognized for its involvement in teaching, learning, service, and research.

This college has an office dedicated to field placement and clinical practice. The office places teacher candidates in partnership schools that are aligned with the college's mission and conceptual framework. Teacher candidates are placed within fifteen surrounding districts in order to give experience within urban, suburban, and rural settings. All placement schools have an assigned university supervisor to provide support to teacher candidates. Teacher candidates are required to spend a half day per methods course.

This large mid-western university has a campus wide initiative for enhancing the critical thinking of undergraduate students. The undergraduate mathematics methods course has been revised to include activities and assessments of critical thinking. The elements of this study align with that initiative. Coaching teacher candidates to become more reflective and move their concerns from themselves to impacting student achievement cannot be accomplished without critical thinking.

For **Phase One**, three elementary university supervisors were selected for the pilot study based on their years of experience. For **Phase Two**, all ten elementary university supervisors in the college were included in the study, as part of a revised programmatic approach. The elementary university supervisors were chosen specifically

as the middle/secondary university supervisors are new to the college and program and are still in the learning process of deciding their policies and procedures. Therefore, they were not ready for participation in this study.

Another set of participants for the study was the teacher candidates. For **Phase One**, there were thirty one students taking either the undergraduate or MAT version of Elementary Mathematics Methods, in addition to seventy-seven students in the student teaching phase of the elementary teaching programs during the spring 2011 semester. The teacher candidates consisted of both undergraduate and graduate pre-service teacher candidates. This ensured the largest sample size possible for this setting. For **Phase Two**, there was a slight decline in the total number of students registered compared to the previous spring semester.

Table 8

Sample for the Spring 2011 semester

	Elementary University Supervisors	Students enrolled in Elem. Math Methods	Elementary BS Student Teachers	Elementary MAT Student Teachers
Total Numbers	10	31	59	18
Number participating	Sample of 3	11	0	7 2 (Interview)

Table 9

Sample for the Fall 2011 semester

	Elementary University Supervisors	Students enrolled in Elem. Math Methods	Elementary BS Student Teachers	Elementary MAT Student Teachers
Total Numbers	11	78	41	10
Number participating	11	78	0	4

Sampling Plan

For **Phase One**, three out of the ten university supervisors were selected to participate in the baseline study. These university supervisors were selected based on their number of years' experience in the role as university supervisor. The criterion for selection was an inexperienced supervisor (one to three years), a supervisor with moderate experience (four to six years) and an experienced university supervisor (seven or more years).

All teacher candidates were invited to participate in the pre-and post-surveys for the study. A sample size of 33 is needed for a medium effect size at an alpha of 0.05 and a power of 80%. As part of the survey document, teacher candidates could agree to an interview and follow-up to the survey. Only 18 teacher candidates volunteered to participate in the data collection of background information and the MBI. A target number of six teacher candidates was planned for the interview; however, two teacher candidates volunteered to participate in the interview.

For **Phase Two**, all eleven elementary university supervisors were included in the study. As part of their contractual obligations participation in program review and analysis is included in their roles and responsibilities. The elementary university supervisors will receive the information about the study at the end of April when contracts are renewed.

All elementary candidates enrolled in either elementary mathematics methods and elementary teacher candidates enrolled in student teaching were invited to participate in the pre and post survey. The teacher candidates were invited to participate in the study during the first class meeting where the survey was administered. The study was explained and consent forms (Appendix B) given. A random sampling of ten candidates participated in the interviews. All forms will be stored in a secure location, accessible only to the researcher based on IRB guidelines.

Instrumentation

This study required the use of pre-assessment and post-assessment questionnaires for the university supervisors and the teacher candidates in both Phase One and Phase Two. Several instruments were examined for possible use in this study. In order to be considered the instrument had to meet these criteria: designed for target audience, alignment to the National Council of Teachers of Mathematics Principles and Standards (2000), and a strong reliability rate. Chamberlin (2010) analyzed the most popular instruments with reliability rates of .80 and above. The table below summarizes his work.

Table 10

Instrument Comparison

Assessment Instrument	Grade Level of Target Audience	Area of Assessment	Aligned to NCTM standards	Reliability Rate
National Longitudinal Study of Mathematical Abilities (NLSMA)	Secondary: Grade 8	Attitude	No	.59-.85
Math Anxiety Rating Scale (MARS)	Tertiary: Freshman-Seniors	Anxiety	No	.78 - .96
Mathematics Attitude Inventory	Tertiary: Freshman in college	Value & Enjoyment	No	Value: .85 Enjoyment: .95 (Aiken, 1974)
Fennema-Sherman Mathematics Attitude Scale	Secondary: High School	Attitude, self-efficacy, motivation, & anxiety	No	Too old for an accurate rate
Attitude Towards Mathematics Inventory	Secondary: High School	Self-efficacy, value, anxiety, motivation	No	.96 (49 items) .97 (40 items)

Based on the criteria chosen for this study, three of these instruments were eliminated due to the target audience; they are the NLSMA, Fennema-Sherman Mathematics Attitude Scale, and Attitude Towards Mathematics Inventory. These inventories were designed for students in middle or high school and would not provide an accurate scale for teacher candidates in college.

Upon further review of the literature three other instruments were considered for this study: Mathematics Belief Instrument (MBI, Hart, 2002), Mathematics Teaching Efficacy Beliefs Instrument (MTEBI, Enochs, Smith, & Huinker, 2000), and Standards

Belief Instrument (SBI, Zollman & Mason, 1992). These instruments are compared in Table 11.

Table 11

Additional Instrument Comparison

Assessment Instrument	Grade Level of Target Audience	Area of Assessment	Aligned to NCTM standards	Reliability Rate
Mathematics Belief Instrument (MBI)	Teachers	Beliefs about NCTM standards, teaching, learning, and efficacy	Yes	.80 Curriculum (NCTM standards) .89 Learner .90 Teacher (Swars, n.d.)
Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)	Teachers	Teaching efficacy, teaching and learning	No	.88 PTME .81 MTOE (Swars, n.d.)
Standards Belief Instrument (SBI)	Teachers	Beliefs about NCTM standards	Yes	.65-.80 (Zollman & Mason, 1992)

The instrument chosen for this study was The Mathematics Belief Instrument (MBI, Hart, 2002). The MBI (Appendix C) assesses attitudes toward mathematics, mathematics pedagogy, mathematics content, and attitudes/beliefs about mathematics and has a reliability rate between 0.80 and 0.90. This instrument is aligned with the National Council of Teachers of Mathematics (NCTM) standards and expectations (Wilkins & Brand, 2004). In addition, the MBI was created as an adaptation from the SBI, so it is an expansion of the SBI instrument.

The Mathematics Beliefs Instrument (MBI) is a 30 item assessment that uses a four point Likert scale and has a reliability rate of 0.80 for the curriculum category, 0.89

for the learner category, and 0.90 for the efficacy (teacher) category (Swars, n.d.).

Cronbach's alpha will be used on the MBI data to test the reliability rate for this study.

In order to triangulate the data interviews with both university supervisors and teacher candidates were conducted. The interviews were semi-structured. Observations of the teacher candidates' teaching and their conferences with the university supervisors were conducted. The observations consisted of observing the university supervisors observing teacher candidates' mathematics lessons and providing feedback. The tool for the university supervisors to use was the Reformed Teaching Observation Protocol (RTOP, Piburn & Swanda, 2000). The RTOP (Appendix E) was chosen because of its reliability rate (0.95), and its alignment to the NCTM standards and research in the field of mathematics education (Piburn & Swanda, 2000; Swanda, et al., 2000). Another reason for this selection is RTOP's success with improving the teaching of mathematics and science; it has been used in several studies (Lawson, 2003; Mitescu, et al., 2011; Pedulla, Mitescu, Jong & Cannady, 2008; Sawada, et al., 2002). The RTOP contains 25 items that are scored on a scale from zero (not observed) to four (very descriptive). The total score ranges from 0-100 points. This instrument measures the extent that reformed based mathematics (or science) is being implemented. The RTOP instrument was introduced during the professional development for the university supervisors and they will use them for observations of teacher candidates teaching mathematics lessons as part of the study. The researcher used the RTOP when observing teacher candidates teaching. The researcher's RTOP scores were compared to the university supervisors RTOP.

Background information was collected from the teacher candidates who participated in the study to provide a reference point for the interviews. A background

questionnaire (Appendix F) was created to obtain this information and was given at the time of the administration of the MBI. The topics for the background instrument were derived partly from the literature review; some topics that are included are: school experience, grades in mathematics content courses, family experiences, GPA, ACT/ GRE score and field placement school. The estimated time for a participant to complete the MBI and the background information was 15 minutes; during the study a few subjects took twenty minutes.

Data Collection

The procedures for the collection of data are outlined in this section. In order to measure the variables a systematic process was created that includes a specific timeline and details for creating the professional development.

Phase One

A random sampling of university supervisors and teacher candidates were the subjects for this part of the study. Upon agreement to participate, the subjects were given the MBI and the background information questionnaire. Scheduling of the observations was set in collaboration with the university supervisors' schedule. The researcher recorded observation data from the university supervisors' conferences with teacher candidates on a t-chart observation form (Appendix G) that will include both observations and reflections. At the close of the semester (April 2011), semi-structured interviews (Appendix H & I) were conducted with both the university supervisors and the teacher candidates. These interviews were recorded, transcribed, and coded for analysis.

Phase Two

All university supervisors participated as part of their contract with the university that requires they attend professional development that is offered. All teacher candidates (BS and MAT) taking mathematics methods and student teaching were invited to participate. If they participated in Phase One, they did not participate in Phase Two. University supervisors were administered the MBI and background information questionnaire prior to the professional development. If the university supervisors participated in Phase One, they did not take the MBI as a pre-assessment. Their MBI from Phase One counted as their pre-assessment. The background information helped in the formation of interview questions. Teacher candidates were given the MBI and background information questionnaire during the first class meeting of mathematics methods and/or their student teaching capstone course or orientation meeting. Scheduling of the observations was set in collaboration with the university supervisors' schedules. The researcher collected observation data from the university supervisors' conferences with teacher candidates on a t-chart observation form (Appendix G) that will include both observations and reflections. The observations of teacher candidates' teaching were conducted after the conclusion of the professional development; a reflection form (Appendix J) was given to the university supervisors to collect feedback on the effectiveness of the professional development. The university supervisors set goals for their coaching of the teacher candidates teaching mathematics for the semester (Appendix K). Observation notes (Appendix G) and reflection forms (Appendix J) were collected during the two follow-up meetings. Reflection forms included the university supervisors' reflections about the professional development. Observations and reflection forms were transcribed and coded for analysis. Data from the RTOP instrument was coded for

analysis. At the close of the semester (December 2011), semi-structured interviews (Appendix H & I) were conducted with both the university supervisors and a random sampling of teacher candidates. These interviews were recorded, transcribed, and coded for analysis.

This study spanned one calendar year including both the spring and fall semester 2011. The spring semester was Phase One of the study and included the months January through April. The treatment (professional development) was provided during the summer. Phase Two began during the fall semester 2011. A timeline was provided on the next page in Table 12.

Table 12

Study Timeline

	Date	Data Collection
Phase One	January 2011	<ul style="list-style-type: none"> • Invite university supervisors, mathematics methods students & student teachers to participate • Administer MBI to three university supervisors and teacher candidates (pre-assessment)
	February 2011	<ul style="list-style-type: none"> • Observations
	March 2011	<ul style="list-style-type: none"> • Observations
	April 2011	<ul style="list-style-type: none"> • Observations • Administer MBI to both university supervisors and teacher candidates (post-assessment) • Semi-formal interviews with random sample of university supervisors and teacher candidates (mathematics methods students & student teachers)
	May 2011	<ul style="list-style-type: none"> • Planning professional development
Phase Two	July-Early August 2011	<ul style="list-style-type: none"> • Confirm university supervisors for Phase 2 of the study • Administer the MBI to university supervisors • Provide professional development in the areas of coaching and mathematics including the use of the RTOP to university supervisors • Have university supervisors set goals
	August 2011	<ul style="list-style-type: none"> • Invite mathematics methods students & student teachers to participate • Administer the MBI to teacher candidates
	September 2011	<ul style="list-style-type: none"> • Follow-up meeting with university supervisors (PD reinforcement, problem solving) • Observations
	October 2011	<ul style="list-style-type: none"> • Observations
	November 2011	<ul style="list-style-type: none"> • Follow-up meeting with university supervisors • Observations
	December 2011	<ul style="list-style-type: none"> • Conduct semi- formal interviews with the university supervisors & a random sampling of teacher candidates (mathematics methods teachers and student teachers) • Administer MBI survey to university supervisors and teacher candidates • Debriefing meeting

Observations and Interviews

All university supervisors were observed at least once when they are using the RTOP and providing feedback to teacher candidates in the post conference. Additional RTOP forms were collected from observations not observed. Semi-formal interviews were conducted at the end of the semester with the ten university supervisors and with ten teacher candidates; all university supervisors and a random sampling of teacher candidates participated in the interviews.

Goal Setting

All university supervisors set goals based on their learning during the professional development. They set goals for the professional development at the beginning of the training. At the close of the professional development, university supervisors set goals regarding their work with teacher candidates in the area of teaching mathematics.

University Supervisors' Meetings

During the regular monthly meetings of university supervisors on campus, time was devoted to the application of the professional development, including a question-answer session, article reviews, and issues and noticings from the field. This was a follow-up to the professional development. Articles and topics for the monthly meetings were chosen based on the issues, goals, and interest of the university supervisors. Articles were an additional resource for the university supervisors. These meetings provided opportunities for mentoring exercises and support to occur. During the semester, there was only one of these follow-up sessions to assist the university supervisors with individual problems, goals or situations in the field. This session continued to provide

coaching strategies and mathematics support to the university supervisors. Instead of providing all the professional development in the summer, the follow-up sessions provided opportunities for the university supervisors to role play and work through problem areas of coaching, in addition to mathematical pedagogy. These meetings were a part of their regular meetings within the semester. Part of their regular meeting was devoted to their role as a coach and their support in the teaching of mathematics.

Data Analysis

This study used a mixed methods design using both qualitative and quantitative methods with a naturalistic approach verses an experimental design (Patton, 2002). A parallel mixed analysis (triangulation of data sources) to analyze the quantitative and qualitative data was also used.

Analyzing the Quantitative Data

The pre-post data was analyzed using descriptive statistics and graphs to determine the shape and spread of the data. Data points were categorized as outliers if they are more than two standard deviations away from the mean. “An outlier is a data point distinct or deviant from the rest of the data” (Pedhazer, 1997).

The relationship between teacher candidates’ beliefs and their background information was highlighted. The variables from the teacher candidates’ background information included: school experience, grades in mathematics content courses, family experiences, GPA, ACT/ GRE score and university supervisor. These demographic variables were used to explain any differences found in the paired samples t-test analysis between the pre and post test data. The significance level was established at $p < .05$ prior to significance testing. The relationship between the university supervisors’ beliefs and

their background information was examined. The demographic variables for the university supervisors were: years of experience, type of mathematics student, and training in mathematics or coaching.

Analyzing the Qualitative Data

The analysis of the qualitative data was on-going during the data collection process due to its interactive, cyclical nature of qualitative data analysis (Miles & Huberman, 1994). The analysis of the qualitative data was continual and on-going using *reflective analysis* (Gall, Borg, Gall, 2005). Reflective analysis was a process in which the researcher depends on his or her own perceptions for analysis verses the traditional categorization process (Gall, et al., 2005). The data from the background information was analyzed upon receipt to provide an initial understanding of the university supervisors and teacher candidate's background and experience; this provided a lens for the analysis and a starting point for identifying themes. These themes lead to conjectures. The conjectures were continually tested, confirmed, or eliminated as a finding. This initial analysis also aided in the continued development of additional interview questions.

A contact summary sheet (Appendix L) and document summary form (Appendix M) were used to organize the field notes and to aid in the organization of the qualitative data gathered from observations and interviews. Interviews were recorded and transcribed. After transcribed, the interviews were analyzed and coded. A folder system was used to house the field notes and contain the summary sheets and document summaries. An Excel spreadsheet detailed the key elements of the folders and summarized the contents; this was a form of indexing and maintaining a table of contents. This organizational system assisted the researcher in finding necessary data.

The coding of the data was done after an observation session or interview. Data was coded using descriptive, explanatory, and interpretive codes. The *reflective analysis* process required continual examination of the data (Gall, et al., 2005). A “start list” of codes (Appendix N) was established based on the literature review; this list was not an exhaustive list and codes were added or removed based on the qualitative data collected (Miles & Huberman, 1994) in addition to the *reflective analysis* process. These steps assisted in the organization and make sense of the qualitative data. Having a systematic way to code and analyze data was important to ensure rigor and reliability.

Positionality

I was a classroom teacher for nine years and a Student Achievement Consultant for three years. I became a National Board Certified Teacher after three years of successful teaching. During my years as a classroom teacher, I coached and mentored both teacher candidates, beginning teachers, and experienced teachers. Teacher candidates visited my classroom for observation hours, and I was a cooperating teacher for a teacher candidate during my eighth year of teaching. This teacher candidate struggled due to his beliefs and attitudes about teaching and learning. He struggled with content knowledge in all areas and teaching for understanding. He was resistant to new ideas and approaches and had difficulty adapting. The university supervisor for this student overlooked a lot of his struggle. We disagreed in his ability to become a teacher. This is where the seed was planted in my interest of teachers’ beliefs and attitudes, as well as, the importance of the role of the university supervisor.

While a Student Achievement Consultant (SAC), I became interested in teacher support. My position as a SAC was primarily that of a district level instructional coach.

My main assignment was one elementary school. As a part of my role, I coached teachers who were new to the district. During this experience, the impact of teachers' beliefs and attitudes toward teaching and learning was evident in student achievement and teaching practices, especially in the area of mathematics. The common trend was a focus on procedural knowledge and a skill and drill approach. During these three years, the district allowed me to expand beyond my building to support mathematics throughout the district. I worked with many teachers in providing support that allowed them to grow and develop new beliefs and attitudes about teaching, learning and mathematics.

During my years as a teacher and SAC, I had to prepare myself for the role of coach. I took a graduate course on mentoring and coaching to help me improve my ability to provide instructional support. I also received training through state initiatives and National Board of Professional Teaching Standards. During this time, I also was asked to teach a mentoring and coaching class at a local university.

For the last year and a half I have been an instructor at a university. It was during this time that I noticed disconnect among the university supervisors, the program, and the teacher candidates. In my course evaluations for elementary mathematics methods, students referenced the mixed messages of their university supervisors, cooperating teachers, and the content of the mathematics methods course. There were also many questions from the university supervisors regarding assignments in mathematics methods that were discussed in faculty meetings.

During my second semester as a full time instructor, I became involved in the critical thinking initiative at the university. One of the readings for this work was Gerald

Nosich's (2009) *Learning to think things through: A guide to critical thinking across the curriculum*. I began making connections between Nosich's "background stories" and the problems with elementary teacher candidates and their teaching of mathematics.

These experiences have aided in the development of my interest and understanding of the impact of teacher candidates' beliefs and attitudes and the impact on the teaching of mathematics. These experiences have also given me the background knowledge of the dynamic between the teacher candidates, the university supervisors, and mathematics methods class. I will also have to be cognizant of my role as an instructor in the program and the impact on study participants.

Limitations

One limitation of the study is the fact that the researcher was a faculty member at the university where the study was conducted. Participants could perceive that they were being evaluated and provide inaccurate responses and behaviors that are perceived acceptable. Another issue with the current design was that the mathematics methods instructors are a confounder. Because the teacher candidates were enrolled in a mathematics methods course, the instructor could possibly have had an impact on teacher candidates' beliefs about mathematics. Additional work and methods are needed in order to adequately address this issue. One possible solution to this is to have the teacher candidates complete reflections after each of their assignments and/or lesson plans that would include the impact of the university supervisor and the methods instructor on the impact of their work. Member cross checking is also another way to assess the impact. One way to assess the impact is to address the impact in the interviews with the participants.

Some factors resulting from the nature of the teaching program may contribute to and/ or impede the teacher candidates' attitudes and background stories; these factors include their placement partner for undergraduate students, their cooperating teacher, and their methods instructor. The teacher candidates can't be isolated from other influences. Many candidates plan and work through lessons with their partners or other peers. The cooperating teacher's philosophy and approach to mathematics also has an impact on the teacher candidates. The methods instructors also will influence and challenge candidates' attitudes and background stories. These influences were considered in the analysis and final instrumentation measures.

Validity Threats

The major threats that could affect the believability of this study are identified below in Table 13.

Table 13

Validity Threats

Four Types of Validity	Validity Threats to Study
Construct <i>"Can we generalize to the constructs?"</i>	Depending on the implementation of this study there could be <u>reactive self-report threats</u> .
Internal <i>"Is the relationship causal?"</i>	<u>Selection bias</u> is an issue for this study as university supervisors and teacher candidates will be a part of this study due to the fact that the researcher is an instructor in the program. <u>Maturation</u> is a risk with this design; the university supervisors and teacher candidates do change and adapt over time. Instrumentation could be an issue, because the observation forms, pre-

	<p>assessment and post-assessments will be the same for both phases of the study. Letting the participants know the expectations shouldn't hinder the effects of the professional development, because this is a common occurrence.</p> <p>History could play a part. It is unknown the participants' knowledge and experience with cognitive coaching, best practices in mathematics and using the RTOP form.</p>
<p>External <i>"Can we generalize to other persons, places, & times?"</i></p>	<p>Sample size could be an issue with this study due to the small number of university supervisors; however this should be comparable to the numbers at other universities. Doing a random sampling of the teacher candidates for the observations and interviews will increase the external validity. However, doing a thorough case study of the experience at one university leads for the call for additional studies in other locations.</p>
<p>Statistical Conclusion <i>"Is there a relationship between cause and effect?"</i></p>	<p>Unreliability of Treatment Implementation could be a problem, because each of the university supervisors could provide varying degrees of support. By using the coaching model, all will have a set standard for their mentoring of the teacher candidates. Also, by providing follow-up sessions and addressing the topics in the monthly meetings, this should increase the likelihood of implementation and the fidelity of the program.</p>

Questions from

Trochim, 2006

In order to maintain the integrity of this design, the effects of these validity threats were minimized. Procedures that were taken to minimize the effects of validity threats are to follow the IRB regulations of maintaining confidentiality of the participants of the

study and include the importance of confidentiality in the briefing and consent forms to decrease the possibility of reactive self-report. This included having another person administer the surveys to the teacher candidates and securing all documents in a locked cabinet. The possibilities of selection bias are evident, as the researcher was an instructor and student at this university. Professional guidelines and adherence to the procedures were followed as outlined in the study. The researcher made a conscious effort during the analysis to ensure that the role at the university did not interfere with the research. Maturation was addressed between the two phases. If the same three university supervisors from phase one participate in phase two, they did not take the MBI at the beginning of phase two; this eliminated them taking the same instrument in April and then again in August. To address the history validity threat, the participants were pre-assessed with questions about their exposure to the RTOP instrument and coaching training. The MBI provided information about their history with mathematics instruction. The threat of sample size was expected. However, using both qualitative and quantitative data and following a strict protocol and procedures compensated for a small sample size. The researcher was diligent documenting, coding, and analyzing the qualitative data. Addressing the possibility of unreliability of treatment implementation was done through the observations, follow-up meetings, and interviews. This was a way to document the extent of their implementation of the coaching techniques and the RTOP instrument.

Reliability

The intentional decision making, the rigor, and the systematic approach to the study are factors in determining reliability. Intentional decision making was documented throughout the study (two phases, data collection and analysis, careful selection of

instruments). This was a strength in determining whether this study could be replicated in a different location. Using strategies to enhance quality provided rigor to the study. These strategies include using a systematic coding procedure and analysis and looking for rival explanations to counter my prior knowledge. Another strength of the design was the systematic nature of the procedures and choice of instrumentation. Due to the qualitative nature of some of the data, thick descriptions were documented to fully capture the data. In addition to thick descriptions, dialogue and quotations were documented to capture conversations and clarifications.

Summary

In an evaluation of an elementary education teacher certification program, this study explored the dynamic between university supervisors and teacher candidates in improving mathematics teaching. The purpose of this study was to investigate the relationship and impact of elementary university supervisors' support with elementary teacher candidates' beliefs about mathematics and their success with teaching mathematics.

The Mathematics Beliefs Instrument (MBI) served as the pre-assessment and post-assessment of both university supervisors' and teacher candidates' beliefs about mathematics. This quantitative data was analyzed using an analysis of variance. Multiple regression was used to compare the variance of teacher beliefs and background information variance, in addition to the university supervisors' beliefs and background information.

The qualitative data was handled systematically. Coding began with a starter list that was revised and organized as the data was analyzed. Interviews were recorded, transcribed, and then coded for analysis.

CHAPTER IV

RESULTS

Introduction

This study examined the impact of university supervisors on their support of teacher candidates' elementary mathematics instruction after the supervisors received professional development in the areas of coaching and mathematics pedagogy. The support of university supervisors includes the ability to skillfully observe instructional segments and provide targeted feedback. University supervisors fill an important role in the education and guidance of teacher candidates. The literature revealed a need to investigate the impact of university supervisors on the support provided to elementary teacher candidates' teaching of mathematics and their impact on teacher candidates' beliefs and instruction. This chapter presents the analysis of the qualitative and quantitative data collected in this program evaluation study. The topics covered in this chapter include: baseline data collected prior to the study, the sample, analysis of the results of the Mathematics Beliefs Instrument (MBI) and the Reformed Observation Teaching Protocol (RTOP), portraits of the university supervisors based on interviews, observations, and background information, interviews with teacher candidates, the research questions, and the program evaluation. The current study was designed to answer the following research questions:

1. What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of elementary teacher candidates?
2. What are the effects of training university supervisors in mathematics education and coaching practices on elementary teacher candidates' beliefs and their instruction in mathematics?

This study used a mixed methods design using both analyses of qualitative and quantitative data to answer these questions. Qualitative data were collected in the form of observations and interviews. These data were transcribed, summarized, and coded when appropriate. Quantitative data were collected through two instruments in the form of The Mathematics Beliefs Instrument (MBI) and the Reformed Teaching Observation Protocol (RTOP). Descriptive statistics were used to provide information about the sample. In order to triangulate the findings, multiple data sources were necessary.

Baseline Data

In order to conduct this program evaluation study, information was gathered in the spring 2011 semester prior to the program change requiring the university supervisors to participate in professional development. Previously, there was no explicit training of university supervisors in any content-related or pedagogical information – as they were only instructed on the procedural components of their jobs. Three experienced university supervisors volunteered and agreed to participate in the baseline study as did three elementary teacher candidates. These six participants agreed to be interviewed to provide information about the program prior to any professional development for supervisors.

Three elementary university supervisors were interviewed prior to the program change in order to gather information about the support of teacher candidates enrolled in the elementary mathematics methods course and the needs of the university supervisor. All three university supervisors described the support that they received from the university as largely how to fill out forms for documentation and the requirements and procedures involved with the visits to candidates at the field sites. They referred to the supervisors' meeting held each semester as sessions to strictly review policies and procedures; with an agenda focused on updates, technology requirements for loading forms, and deadlines. All three elementary university supervisors described examples of the meeting content as seeking clarification about requirements and protocols from either the director of field placements or from one long-term university supervisor. One university supervisor said that she depends on "Other experienced supervisors that have been around longer than me. I mean I don't know how long (she) has done it, but she's very meticulous about making sure she follows the protocol, and I like that because that's like I told you, that's me." None mentioned support or training in how to handle post-conferences that include possible approaches to conferring with teacher candidates that foster reflection or any information related to the content knowledge or pedagogical knowledge expected of teacher candidates or required to effectively supervise a lesson at the elementary level.

One responsibility of the university supervisors as part of their roles in their assigned professional development sites was the expectation to provide professional development to classroom teachers at the field placement schools. However, two of the three university supervisors interviewed never mentioned this as one of the ways to

bridge support between the university and the field placement school. However, one university supervisor addressed this expectation by saying, “Yes, I would love to (provide professional development), but I would have to have that invitation you know; I don’t want someone (in the placement school) to come in and act like I’m Miss Know It All.” The university supervisor did not want the staff of the school to view her as someone there to implement change, but instead as a resource if the school faculty seeks her expertise. All three university supervisors were uncomfortable acting as a resource to the field placement site when university expectations of teaching mathematics as identified in the teacher candidates’ assignments differed from the observed practice of the cooperating teachers. All three talked about witnessing teaching practices that are not aligned with the high quality mathematics instructional practices professed in the mathematics methods courses. One university supervisor said, “As a supervisor that’s not my job.” The same supervisor described observing teaching at her placement school by the classroom teachers and says that she “just wants to close her eyes.” Another specifically managed the disconnect between what students are learning in their mathematics methods courses and what they are experiencing in the field placement by talking with the teacher candidates in an indirect manner, suggesting they “back off from the worksheets.” But the same supervisor stated that she allowed teacher candidates to use worksheets, because the cooperating teachers use them. She suggested instead that the instructors for elementary mathematics methods courses should address this issue of the non-examples that the teacher candidates will see in the field, and didn’t feel comfortable addressing it herself with the faculty at the placement school.

When the supervisors were asked about how they each support teacher candidates in the planning and development of their lessons for the mathematics teaching assignments the answers varied. One supervisor said, “I haven’t had to help the methods students at all in that process.” She said that she only conferred with teacher candidates after they taught their lessons. Another said she didn’t meet with the teacher candidates prior to teaching, but mentioned some teacher candidates would want her input and opinion about their lessons and would seek her assistance. Another responded with an example of one candidate’s end of the semester feedback; she shared that the candidate stated that the university supervisor was too lenient. The supervisor responded to the feedback by telling the candidate that her assessment of the teaching “isn’t really an evaluation.” The university supervisor explained that she didn’t see herself as the person who gave the grade, but a person to help assess whether the teacher candidates have met the (teaching) standards; this is contrary to the actual reality as university supervisors do assign grades. The university supervisor went on to say that she can analyze a lesson and “find some evidence of the standards somewhere,” if she looks hard enough. She wants the teacher candidates to be successful and see the elements of the standards within their teaching practice.

These three university supervisors shared their ideal characteristics of an effective elementary mathematics lesson. The characteristics are summarized in Table 14.

Table 14

Characteristics of Elementary Mathematics Lessons

<i>Characteristic</i>	<i>Number of responses (n=3)</i>
Hands-on	1
Students sharing their thinking	2
Teacher questioning	1
Student engagement	2
Student talk	1
I can statements (objectives)	1
Student self-assessment	1
Accuracy of the mathematics content	1

All three elementary university supervisors gave specific examples of times where they had to address a mathematical content error in teacher candidates' teaching. In two instances, it was necessary for the supervisor to address it during the teaching episode. One supervisor approached the teacher candidate and whispered the error so she could address it immediately and avoid serious student confusion. Another supervisor spoke up during the lesson and posed the content error as a question to the class, stating that "she was confused." The third supervisor addressed the content error during the post conference. She stated that the most common error is with precision of language; "they do not always use the appropriate terms when teaching." She then shared that the teacher candidates get nervous and forget, so she understood.

Three teacher candidates (two undergraduates and one graduate) were interviewed about their experience with elementary mathematics methods and the field placement component. One candidate described herself as a strong mathematics student, one described herself as a strong mathematics student until she reached college, and the other stated that she struggled with mathematics since elementary school. Despite their different self-described ability levels, they all spoke positively about their elementary

mathematics methods experience. All three candidates described that they gained insight into the conceptual understanding of mathematics through taking the course. They credit this positive learning experience to their instructor. All three spoke highly of their university supervisor's support, as well. However, each detailed the support further by crediting the supervisor with supporting them with classroom management and implementation strategies with none mentioning content knowledge or pedagogical content knowledge support. One teacher candidate stated:

Well that's kind of her job. She (the university supervisor) knew the different things that –like the pet peeves that get on our nerves and the little things to ignore. She knew how to do management like as far as switching things up, and in an actual school how their management plan worked, and how we can change some of those things to make it specific to us.

One teacher candidate found her cooperating teacher beneficial; this candidate found the cooperating teacher to be a resource and she received assistance in planning and helpful feedback to the teacher candidate.

The three teacher candidates in this baseline data collection shared a change in their beliefs about teaching mathematics that occurred during the mathematics methods semester. Each learned that elementary students should discover and invent computational strategies instead of just listening to the teacher repeat procedures and giving them back. One teacher candidate mentioned the disconnect found between the practices described in her elementary mathematics methods class and those used by her cooperating teacher. She found the cooperating teacher to be very traditional, and he disagreed with her methods instructor about the use of vocabulary. During the post-

observation, this teacher candidate shared the advice that she received from her mathematics methods instructor, and he (the cooperating teacher) outright disagreed. The cooperating teacher said he disagreed with not including the vocabulary into the lesson.

The teacher candidate shared:

He said I didn't use the words denominator and numerator; which I didn't, because in my math methods class she said "Don't use those until they learn it a little more. He disagreed with this."

She shared she wished her university supervisor would have talked with him.

The teacher candidates enrolled in the elementary mathematics methods course during the spring 2011 semester were invited to complete the Mathematics Beliefs Instrument (MBI) to further gain information about the beliefs of teacher candidates in the program; eighteen teacher candidates completed the survey. The three elementary university supervisors who participated in this baseline data collection also agreed to complete the MBI. A summary of their responses are found in Appendix P; on this table, US is used to label the university supervisors' responses, and TC is used to label the teacher candidates' responses. Part A of the MBI are *agree or disagree* statements. Part B and C are a four level scale: *true, more true than false, more false than true, and false*. The last column of the table in all three sections is for subjects who failed to respond or responded with multiple answers. One teacher candidate only answered Part A.

Some important areas of the results of the Mathematics Beliefs Instrument (MBI) will be summarized. Twenty-eight percent (n=5) of the teacher candidates and 33% (n=1) of university supervisor believe students should justify their work in a single way. In comparison, 6% (n=1) of teacher candidate and 33% (n=1) of the university supervisor

believe that for most math problems students have to be taught the correct procedure. In contrast, all 100% (n=3) of university supervisors believe that there is more than one correct way to solve math problems, and in contrast six percent (n=1) of the teacher candidate believes there is just one way to solve math problems. Fifty-six percent (n=10) of the teacher candidates and 33% (n=1) of the university supervisor believe there should be an increased emphasis on reading and writing mathematical symbols.

When it comes to beliefs about learning, 61% (n=11) of the teacher candidates and 33% (n=1) of the university supervisor believe that learning mathematics is absorbed. Elements of teaching mathematics include teaching via problem solving instead of with key words and teaching for a quick response. Two university supervisors and one teacher candidate believe an increase in emphasizing key words is important to mathematics instruction. Sixty-seven percent (n=2) of the university supervisors and 11% (n=2) of the teacher candidates responded that to be good at math you must be able to solve problems quickly.

Some traditional beliefs about mathematics include believing that some people are mathematically challenged and that it is socially acceptable to believe that one does not have the power to change. Twenty-eight percent (n=5) of the teacher candidates responded that they believe that some people are good at mathematics and some are not; in comparison to all subjects (100%) believing that students have the power to control their own success. Thirty-three percent (n=1) of the university supervisors marked that she was not very good at learning mathematics.

These highlighted results from the survey and interviews displayed a need for intervention and have informed the current study. The traditional views are in opposition

to the recently adopted reform efforts from the National Council of Teachers of Mathematics (NCTM) and the adoption of the Common Core Standards (CCSSO, 2010). University supervisors need some professional development in the areas of conceptual understanding and flexibility in thinking and strategies as evidenced from two supervisors holding beliefs about K-5 students' problem solving in a single way, one responding to increasing the use of reading and writing symbolically, and one university supervisor not responding to that question. University supervisors need to be aligned philosophically with research-based national standards professed by the elementary mathematics methods instructors in order to provide cohesiveness in the support and development of future elementary teachers of mathematics. The university supervisors also need to be supported with techniques and strategies in coaching to provide support beyond classroom management and implementation strategies. The teacher candidates need support outside of elementary mathematics methods class to highlight areas of problem solving, conceptual understanding, and student diversity as they try to implement new learnings out in the field placement schools.

The Current Study

Description of the Sample

Eleven university supervisors (n=11) and eighty-three teacher candidates (n=83) participated in this study from August through December 2011. Each university supervisor participated in a day and a half of professional development during the summer and one follow-up professional development session in the fall. Each university supervisor completed the Mathematics Beliefs Instrument (MBI, Appendix C) prior to the professional development and the same instrument was administered again at the end of

the semester in December. The university supervisors also completed the Reformed Teaching Observation Protocol (RTOP, Appendix E) for every mathematics observation of teacher candidates who were either in their methods placement or in their student teaching. The supervisors were observed by the researcher twice as they were leading the post-observation conference with the teacher candidates; this observation included the researcher and the university supervisor simultaneously completing the RTOP for the teacher candidate's teaching. University supervisors also participated in a culminating interview.

Table 15 displays the demographic data for the university supervisors, including gender, highest degree earned, overall teaching experience at the elementary level, experience teaching mathematics, total years in education, years of university supervisor experience, previous mentoring/ coaching training, National Council of Teacher of Mathematics (NCTM) membership, National Board Certified Teacher certification, and faculty status with the university. One hundred percent (n=11) of the elementary university supervisors participating in this study were female. Eighty-two percent of the university supervisors (n=9) have earned a master's degree, six of those have an additional 30 credit hours beyond a master's degree (55%), and two (18%) have earned a doctorate. The average of years in education was 33 years with the range of experience in education being 16 to 41 years. Teaching experience ranged from 16 years to 41 years, with the average being 29.5 years. The years of experience teaching mathematics averaged approximately 24 years, with the range being from 10 to 34 years. Five university supervisors (45%) have attended a mentor/coaching training before, with six (55%) not having any previous training. None of the university supervisors are NCTM

members or National Board Certified Teachers. Two (18%) university supervisors are full-time professors with the university, one (9%) is a full-time instructor, and one (9%) is a part-time instructor teaching one class a semester.

Table 15

Demographic and Professional Characteristics of University Supervisor Participants

Characteristic		Frequency	Percent
Gender	Male	0	0
	Female	11	100.00
Highest degree earned	Bachelors	0	0
	Masters	3	27.27
	Masters plus 30	6	54.54
	Doctorate	2	18.18
Years of teaching experience	1-10 years	0	0
	11-20 years	2	18.18
	21-30 years	2	18.18
	31 years or more	7	63.63
Experience teaching mathematics	1-10 years	2	18.18
	11-20 years	2	18.18
	21-30 years	3	27.27
	31 years or more	4	36.36
Total years in education	1-10 years	0	0
	11-20 years	1	9.09
	21-30 years	2	18.18
	31 years or more	8	72.72
Experience as a university supervisor	0-1 year	2	18.18
	2-3 years	3	27.27
	4-5 years	0	0
	6-7 years	1	9.09
	8 years or more	5	45.45
Previous training as a mentor/ coach	Yes	5	45.45
	No	6	54.54
NCTM member	Yes	0	0
	No	11	100.00
National Board Certified Teacher	Yes	0	0
	No	11	100.00
University faculty rank (if faculty)	Full-time professor	2	18.18
	Full-time instructor	1	9.09
	Part-time instructor	1	9.09
	Not a faculty member	7	63.63

Eighty-three teacher candidates participated in the current study. Seventy-eight teacher candidates were enrolled in mathematics methods with the other seven candidates in student teaching; all of these teacher candidates were administered the Mathematics Beliefs Instrument (MBI, Appendix C) at both the beginning and the end of the semester. Ten of the teacher candidates also volunteered for an end of the semester interview. Nineteen teacher candidates were observed by the researcher as they were teaching a mathematics lesson that was simultaneously being observed by the supervisor. Five of the 83 participating teacher candidates were student teachers; these teacher candidates participated in the observation and post-conference with the supervisor and the researcher. These post conferences are always conducted for any formal observation as part of program expectations. These five teacher candidates did not participate in the pre-post administration of the MBI.

Table 16 displays the demographic data for the 78 teacher candidates who provided background information with the MBI at the beginning of the study. Of the 78 teacher candidates, 73 were female (92%) and five were male (6%). All were enrolled in an initial elementary education teacher certification program; 44 teacher candidates were enrolled in the Bachelors of Science program and 35 were enrolled in the Masters of Arts of Teaching program. Grade point averages for the participants ranged from 2.75 to 4.00 with 3.50 the average. Depending on the program, teacher candidates either were required to take the ACT or the GRE. ACT scores ranged from 20 to 33, with a mean score of 24. GRE scores (verbal and quantitative combined) ranged from 790 to 1170, with 932 being the mean combined score. Twenty-four teacher candidates did not report their ACT or GRE score.

Table 16

Demographic and Professional Characteristics of Teacher Candidate Participants

Characteristic		Frequency	Percent
Gender	Male	5	6.33
	Female	73	92.41
Age	19 years or younger	1	1.27
	20-24 years	56	70.89
	25-29 years	11	13.92
	30-34 years	1	1.27
	35-39 years	2	2.53
	40-44 years	2	2.53
	45 years or older	4	5.06
	Failed to report	3	3.80
Program degree	Bachelors	44	55.70
	MAT	35	44.30
GPA	3.8-4.0	28	35.44
	3.5-3.7	21	26.58
	3.2-3.4	18	22.78
	3.0-3.1	4	5.06
	Below 3.0	0	0
	Failed to report	6	7.59
ACT scores for BS candidates	30 or above	3	3.80
	25-29	11	13.92
	20-24	24	30.38
	19 or below	0	0
or			
GRE scores for MAT candidates	1100 or above	2	2.53
	1000-1099	3	3.80
	950-999	1	1.27
	900-949	2	2.53
	850-899	4	5.06
	800-849	4	5.06
	Below 800	1	1.27
Failed to report		24	30.38

Additional information was collected from the teacher candidates about their experiences specifically with mathematics. Grades from the two required prerequisite elementary mathematics content courses, parents' attitudes about mathematics, parents' education, and the level of mathematics achievement are summarized in Table 17.

Because the two elementary mathematics courses are prerequisite courses, candidates must have a grade of C or higher in order to be admitted into the program. Despite this requirement, one student self-reported a D in Math 152. Forty-one percent of teacher candidates (n=32) earned an A in Math 151; twenty-nine percent (n=23) earned a B, and 20% (n=16) earned a C with 10% (n=8) failing to report their grade for Math 151. For Math 152, the distribution was 39% (n=31) earned an A, 33% (n=26) earned a B, and 9% (n=7) earned a C. with 11% (n=9) failing to report their Math 152 grade.

Teacher candidates reported their parents' attitude about mathematics. Only six percent (n=5) rated their parents' attitudes toward mathematics as negative. Fourteen percent (n=11) were uncertain about their parents' attitudes. Forty-eight percent of teacher candidates (n=38) rated their parents' attitude as positive, and 32% (n=25) rated their parents' attitudes as very positive. Teacher candidates also provided information about their parents' education background. Two of the teacher candidates' fathers do not have a high school diploma; this is consistent with report about the mothers' educational background with two not having a high school diploma. Note that the four parents without a high school diploma belong to four different teacher candidates. Parents with only high school diplomas include 38% of fathers and 41% of mothers. Two-year college degrees are held by 19% of teacher candidates' fathers and 17% of mothers. Four year college degrees are held by 22% of fathers and 27% of mothers. Graduate degrees are held by 19% of fathers and 14% of mothers. In addition, teacher candidates classified their overall level of mathematics achievement. One teacher candidate answered below average, twenty-three (29%) answered average, twenty-six (33%) answered above

average, and twenty-nine (37%) answered that they had a high level of mathematics achievement.

Table 17

Mathematical Background and Experiences of Teacher Candidates

Characteristic		Frequency	Percent
Grades Elementary mathematics course # 1	A	32	40.51
	B	23	29.11
	C	16	20.25
	Failed to report	8	10.13
Elementary mathematics course #2	A	31	39.24
	B	26	32.91
	C	7	8.86
	D	1	1.27
	Failed to report	9	11.39
Parents' attitudes about mathematics	Very negative	2	2.53
	Negative	3	3.80
	Uncertain	11	13.92
	Positive	38	48.10
	Very positive	25	31.65
Father's education background	Did not graduate high school	2	2.53
	High school graduation	30	37.97
	2-Year college graduation	15	18.99
	4-Year college graduation	17	21.52
	Graduate school graduation	15	18.99
Mother's education background	Did not graduate high school	2	2.53
	High school graduation	32	40.51
	2-Year college graduation	13	16.46
	4-Year college graduation	21	26.58
	Graduate school graduation	11	13.92
Self-reported level of candidates' mathematics achievement	High	29	36.71
	Above average	26	32.91
	Average	23	29.11
	Below average	1	1.27
	Low	0	0

Description of the Professional Development (Treatment)

As part of this program evaluation study, the university supervisors participated in professional development; agendas for the professional development are located in Appendices Q and R. University supervisors were given two options of dates to attend the professional development sessions. Eight university supervisors attended the full day session on August 2, 2011 and one university supervisor attended on August 9, 2001. The half-day session on August 3, 2011 was attended by five university supervisors, and three attended the half day on August 11, 2011. Two university supervisors had to have individual full-day professional development sessions due to scheduling conflicts and illness. One university supervisor had to have an individual half-day session.

The topics for the professional development were chosen based on the literature regarding best practices for professional development. According to Obara (2010), professional development should include topics of curriculum and content knowledge, so the professional development included the pedagogy connected to high quality mathematics instruction at the elementary grades. The professional development also included the skills and methods of a coach (Gordon & Brobeck, 2010) which included: questioning strategies, observation approaches, documentation, conferencing, and relationship building. Supervisors were trained in the use of the RTOP for observations. The elementary university supervisors were trained to use the RTOP by reviewing the instrument, watching a video of an exemplary elementary mathematics teaching practice, and by assessing their ratings of the observed teaching. Then university supervisors debriefed and shared their results. They asked clarifying questions, and examples of descriptors were given. Due to the limitation of time allotted by the department for the

professional development sessions, two common coaching strategies were selected as the main focus: paraphrasing and questioning. These two strategies were selected because they are universal strategies of many coaching models (Costa & Garmston, 2002; NBPTS, 2008; Sherris, 2010; Staub, West, & Bickle, 2003). Techniques for coaching using these two strategies were presented, modeled, and practiced. The expectation was set that the supervisors would paraphrase after each time the teacher candidate speaks and before asking a question. Four types of questions were shared in the professional development: open-ended, mediating, probing and closed questions. In addition to the coaching strategies, the professional development included best practices in teaching elementary mathematics. Expectations for instruction provided by the National Council of Teachers of Mathematics and the elements of instruction identified in the RTOP (Piburn & Swanda, 2000) were the key components of the mathematics portion of the training (all aligned with the Common Core Standards in Mathematics (CCSSO, 2010). At the end of the professional development, the university supervisors set one to two professional goals for them to focus on during the semester. This was to establish a commitment to personal goals. The type of goal and the frequency of the responses are summarized in Table 18.

Table 18

Established Goals of University Supervisors

Goal	Frequency
Questioning	6
Paraphrasing	7
Body Language	1
Engage in Reflective Practice	1
No Response	2

A scheduled follow-up session was held in October 2011; seven university supervisors participated in the session. One followed up with a phone conference. The director of field and clinical placements followed up with the others. During this time, coaching strategies were reviewed and modeled. The university supervisors also revisited the goals that were set at the beginning of the semester. The agenda for the follow-up professional development session is Appendix S. Questions were also addressed in a review of the RTOP. University supervisors were also provided with an article on coaching that pertained to one of the focal coaching strategies - questioning.

Analysis

Mathematics Beliefs Instrument

All participants including the supervisors and the teacher candidates in methods courses completed the Mathematics Belief Instrument in a pre- post design. Teacher candidates completed the instrument on the first day of their elementary mathematics methods course and again on the last day of class. The university supervisors completed

the instrument prior to the professional development and at the end of the semester in December 2011.

The university supervisors' responses were coded and entered into the Statistical Package for the Social Sciences (SPSS) to be analyzed. Questions were coded so that the highest score exemplified a constructivist or reformed based view of mathematics and the lowest score characterized a traditional view of mathematics (Smith, 2010); this means some questions were reverse coded so that the means would be meaningful. A paired samples t-test was used to compare the mean score for the three sections of the MBI: curriculum, learning, and efficacy. The expectation is that the pre-test scores should be lower than the post-test scores and thus causing the t-value to be negative. Effect sizes (r) were calculated for significant t-scores. The results for the elementary university supervisors are reported in Table 19.

Table 19

MBI Pre-Post Comparison for the University Supervisors

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	11	1.77	.14	1.77	.15	-.15	.88
Learning	11	3.36	.40	3.40	.35	-.53	.61
Efficacy	11	2.91	.89	2.82	.93	.80	.44

The university supervisors did not have a significant change in beliefs. The change in means for curriculum and learning were slight but still moved toward more constructivist views. Because the t score is positive, efficacy made a slight change toward the traditional viewpoint.

To visually see the comparison of responses for each question, the responses were tabulated and presented in Appendix T. Pre-assessment scores are posted on the top line and post-scores are posted underneath in order to make a visual comparison.

The pre and post MBI data revealed some interesting findings. For the most part, the university supervisors were consistent between their pre and post responses. University supervisors believe that students should share their thinking with others. They believe that mathematics should be thought of as a meaningful language if students are to communicate and apply mathematics productively. The university supervisors believe that mathematics should include other curriculum areas, and that the strands of mathematics should not be taught in isolation. They believe that to be good at solving problems you do not have to be quick. The university supervisors believe that good reasoning is more important than finding correct answers, and that mathematics should be an active process. They also believe that good mathematics teachers show students multiple ways to look at the same question.

A majority of the university supervisors believe that problem solving is not a separate, distinct part of the mathematics curriculum. While two supervisors believed that it should be separate at the beginning of the semester, only one believes that it should be separate at the conclusion of the semester. At the beginning of the semester nine university supervisors felt there should be an increased emphasis on clue/key words in problem solving, this dropped to only one at the end of the semester. The university supervisors remain split on increasing the emphasis on reading and writing mathematics symbols; five agreed on the pre assessment, and six agreed on the post assessment. They were also split on their views of having to be specifically taught the correct procedure to

solve most math problems. At the beginning of the semester, three were leaning toward that being true, while at the end four believed this to be true.

An interesting change from the pre and post assessment data was that eleven university supervisors believed you can be creative and discover things by yourself in mathematics; on the post assessment one university supervisor changed their thinking about being creative and discover things on your own.

The last two questions relate directly to the topic of efficacy. At the beginning of the semester, three university supervisors felt they were not good at learning mathematics; and that number grew to four supervisors at the end of the semester. On the pre-assessment, two university supervisors answered “false” about being good at teaching mathematics. On the post assessment, one moved to “more false than true” and one remained as “false.”

Teacher candidates enrolled in elementary mathematics methods courses completed the MBI on the first day of class and again on the last day of class to capture changes in beliefs about mathematics instruction over the course of the semester. The teacher responses were coded and entered into the Statistical Package for the Social Sciences (SPSS) to be analyzed First, analysis of covariance (ANCOVA) was utilized to reduce the effects of statistical difference between groups (Creswell, 2002). The groups consisted of the 11 university supervisors. Pre and post MBI mean scores were calculated. The results from the ANCOVA are found in Table 20.

Table 20

Differences Between Groups Analysis of MBI scores

Dependent Variable: Post MBI

Source	df	Mean Square	F	Sig.
Pre-Overall	1	0.640	21.283	.000
Pre-Curriculum	1	0.007	0.228	.228
Pre-Teaching	1	1.923	6.915	.000
Pre-Efficacy	1	4.770	8.986	.004

The ANCOVA revealed that there was a statistical difference between the overall pre and post MBI beliefs. There was also a statistical difference between the beliefs about teaching and efficacy from the beginning of the study to the end. There was not a statistical difference between the pre and post MBI beliefs about curriculum.

In addition to the ANCOVA, paired samples t-tests were employed to decide if the university supervisor affected the beliefs of teacher candidates; this was also used to determine if the elementary mathematics methods instructor affected the beliefs of teacher candidates. Paired samples t-tests are used when the same subjects (teacher candidates) are tested twice and to determine the probability of rejecting the null hypothesis (McMillian & Schumacher, 2006) that the mean scores would be identical. The teacher candidates were grouped by mathematics methods instructor and by university supervisor. Because subjects' data was used in two analysis (university supervisor and instructor), the Bonferroni correction was applied and established the p value for significance at .025. Individual student results were not reported because the focus of the study was the impact of the university supervisor. A paired samples t-test

was used to compare the mean score for the three sections of the MBI: curriculum, learning, and efficacy.

Teacher candidates were first grouped according to their university supervisor. The names for the eleven elementary university supervisors have been changed in order to maintain confidentiality. The first supervisor is Amy, and the results for her five teacher candidates are found in Table 21.

Table 21

Analysis of Amy's teacher candidates' MBI scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	5	1.7	.07	1.8	.11	-3.0	.04
Learning	5	3.1	.46	3.4	.30	-2.5	.07
Efficacy	5	2.9	.42	3.3	.45	-1.6	.18

There was not a significant difference in the pre and post mean scores even though they increased for the curriculum section of the MBI for Amy's student, $t(4) = -3.0$, $p < .025$.

Differences in the pre and post for learning and efficacy did reveal an increase in the means, but these differences were not significant.

The second university supervisor is Brenda; she was assigned nine teacher candidates. Her candidates experienced a significant change in their curriculum, as reported in Table 22.

Table 22

Analysis of Brenda's Teacher Candidates' MBI scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	9	1.63	.09	1.77	.11	-4.6	.00
Learning	9	3.14	.48	3.65	.39	-2.4	.04
Efficacy	9	2.89	.65	3.33	.75	-2.1	.07

There was a significant difference in the pre and post mean scores for the curriculum section of the MBI for the teacher candidates who worked with Brenda. Teacher candidates moved toward more constructivist views about curriculum when comparing pre curriculum beliefs ($M=1.63$, $SE=.03$) to the post curriculum beliefs ($M=1.77$, $SE=.04$). This difference is significant $t(8)=-4.6$, $p<.025$ and represented a large effect size $r=.73$. Teacher candidates also experienced an increase in beliefs about learning; however this change in mean scores was not significant. Differences in the pre and post belief scores for efficacy did reveal an increase in the means, but these were not significant.

Cindy was another university supervisor assigned six teacher candidates. Slight changes in the mean scores of the teacher candidates who worked with her are noted, but none were significant. Cindy's teacher candidates' mean scores for curriculum and efficacy actually shifted toward more traditional beliefs as the t-scores are positive, as displayed in Table 23.

Table 23

Analysis of Cindy's Teacher Candidates MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	6	1.65	.03	1.64	.07	.36	.74
Learning	6	3.08	.48	3.28	.27	-1.23	.28
Efficacy	6	3.08	.63	3.00	.63	.54	.61

The differences in the pre and post for curriculum for Cindy's teacher candidates were not significant $t(5)=.36$, $p>.025$. The differences in the pre and post for learning were not significant $t(5)=-1.23$, $p>.025$. Also the differences in the pre and post for efficacy were not significant $t(5)=-.54$, $p>.025$.

A fourth elementary supervisor is Deb. She was assigned eleven teacher candidates. Her teacher candidates exhibited a significant change in curriculum and learning beliefs as measured on the MBI. The results of Deb's teacher candidates are reported in Table 24.

Table 24

Analysis of Deb's Teacher Candidates MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	11	1.61	.12	1.73	.08	-3.31	.01
Learning	11	3.05	.25	3.39	.36	-.03	.04
Efficacy	11	3.23	.88	3.36	.64	-.61	.56

There was a significant difference in the pre and post mean scores for the curriculum construct of the MBI for Deb's teacher candidates. Her teacher candidates moved toward

more constructivist views about curriculum when comparing pre curriculum beliefs (M=1.6, SE=.04) to the post curriculum beliefs (M=1.7, SE=.02). This difference is significant $t(10)=-3.30$, $p<.025$ and represents a large effect size $r=.52$. Teacher candidates moved toward more constructivist views about learning as identified when comparing pre learning beliefs (M=3.05, SE=.07) to the post learning beliefs (M=3.39, SE=.11). This difference was not significant $t(10)=-2.41$, $p>.025$. Differences in the pre and post belief scores for efficacy did reveal an increase in the means, but these differences were not significant.

The fifth university supervisor is Emily. Six teacher candidates were assigned to Emily. The results from the paired samples t-test are found in Table 25.

Table 25

Analysis of Emily's Teacher Candidates MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	6	1.62	.11	1.80	.05	-3.43	.02
Learning	6	3.1	.43	3.57	.50	-2.84	.04
Efficacy	6	2.92	.66	3.50	.55	-1.56	.18

There was a significant difference in the pre and post mean scores for the curriculum and learning sections of the MBI for Emily's teacher candidates. The teacher candidates moved toward more constructivist views about curriculum when comparing pre curriculum beliefs (M=1.6, SE=.04) to the post curriculum beliefs (M=1.8, SE=.02). This difference is significant $t(5)=-3.43$, $p<.025$ and represents a large effect size $r=.70$.

Teacher candidates moved toward more constructivist views about learning. When comparing pre learning beliefs (M=3.10, SE=.18) to the post learning beliefs (M=3.57,

SE= .20). This difference was not significant $t(5)=-2.84$, $p>.025$. Differences in the pre and post for efficacy did reveal an increase in the means, but these differences were not significant.

Another university supervisor is Fran who was assigned ten teacher candidates. For her group, the area of learning represented significant change in beliefs. The other areas demonstrated a change in mean scores, but the change was not significant as displayed in Table 26.

Table 26

Analysis of Fran's teacher candidates MBI scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	10	1.65	.07	1.74	.12	-2.13	.06
Learning	10	2.84	.55	3.46	.51	-3.93	.00
Efficacy	10	3.05	.80	3.20	.79	-.90	.39

Fran's teacher candidates moved toward more constructivist views about learning. There was a significant difference in the pre and post mean scores for the learning section of the MBI. Pre- learning beliefs ($M=2.84$, $SE=.17$) were compared to the post curriculum beliefs ($M=3.46$, $SE=.16$). This difference is significant $t(9)=-3.93$, $p<.025$ and represents a large effect size $r=.63$. Differences in the pre and post for curriculum and efficacy did reveal an increase in the means, but these were not significant.

The next university supervisor is Gina; she was assigned five teacher candidates. Her teacher candidates displayed a change in beliefs toward more constructivist views in all three constructs of the MBI, however, the change was not significant. The analysis for her teacher candidates is found in Table 27.

Table 27

Analysis of Gina's teacher candidates MBI scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	5	1.69	.11	1.79	.03	-1.81	.15
Learning	5	3.05	.61	3.35	.33	-1.08	.34
Efficacy	5	2.90	.22	3.40	.42	-2.23	.09

The differences for Gina's teacher candidates in the pre and post for curriculum were not significant $t(4) = -1.81, p > .025$. The differences in the pre and post for learning were not significant $t(4) = -1.08, p > .025$. Also the differences in the pre and post for efficacy were not significant $t(4) = -2.23, p > .025$.

Helen was another university supervisor and was assigned four teacher candidates. Her teacher candidates displayed a change toward more constructivist views in all three areas of the MBI, however none were significant. The analysis of Helen's teacher candidates is found in Table 28.

Table 28

Analysis of Helen's Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	4	1.70	.05	1.82	.04	-1.29	.29
Learning	4	3.48	.27	3.61	.23	-2.38	.10
Efficacy	4	2.63	.55	2.88	.13	-.42	.70

The differences in the pre and post for curriculum were not significant $t(3) = -1.29, p > .025$. The differences in the pre and post for learning were not significant $t(3) = -$

2.38, $p > .025$. Also the differences in the pre and post for efficacy were not significant $t(3) = -.42$, $p > .025$.

Next, Jill was assigned five teacher candidates. Her teacher candidates did display a change in beliefs for all three constructs of the MBI. None of these changes to the means were significant. Jill's results are summarized in Table 29.

Table 29

Analysis of Jill's Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	5	1.61	.16	1.70	.14	-1.11	.33
Learning	5	3.21	.80	3.52	.22	-.74	.50
Efficacy	5	2.20	1.44	3.40	.55	-1.67	.17

The differences in the teacher candidates' pre and post for curriculum were not significant $t(4) = -1.11$, $p > .025$. The differences in the pre and post for learning were not significant $t(4) = -.74$, $p > .025$. Also the differences in the pre and post for efficacy were not significant $t(4) = -1.67$, $p > .025$.

The tenth university supervisor is Kim; she was assigned four teacher candidates. On average, the teacher candidates exhibited a change in beliefs for each of the three constructs. These changes in beliefs were not significant. Table 30 displays the analysis for Kim's teacher candidates.

Table 30

Analysis of Kim's Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	4	1.64	.05	1.72	.10	-1.03	.38
Learning	4	2.94	.37	3.4	.24	-3.08	.05
Efficacy	4	2.75	.32	2.9	.52	-.52	.64

The differences in the pre and post for curriculum were not significant $t(3) = -1.03$, $p > .025$. The differences in the pre and post for learning were not significant $t(3) = -3.08$, $p > .025$. Also the differences in the pre and post for efficacy were not significant $t(3) = -.52$, $p > .025$.

The last university supervisor is Linda. Twelve teacher candidates were assigned to Linda. Her candidates displayed a change toward more constructivist views in all three areas, however only two were significant. The analysis of Linda's teacher candidates is found in Table 31.

Table 31

Analysis of Linda's Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	12	1.63	.02	1.71	.04	-2.12	.06
Learning	12	3.08	.09	3.38	.10	-3.74	.00
Efficacy	12	2.83	.21	3.25	.20	-3.46	.01

Linda's teacher candidates moved toward more constructivist views about learning.

There was a significant difference in the pre and post mean scores for the learning section

of the MBI. Pre- learning beliefs ($M=3.08$, $SE=.09$) were compared to the post curriculum beliefs ($M=3.38$, $SE=.10$). This difference is significant $t(11) = -3.73$, $p < .025$ and represents a medium effect size $r = .30$. There was also a significant difference in the pre and post mean scores for efficacy. Pre-efficacy beliefs ($M=2.83$, $SE=.21$) were compared to the post curriculum beliefs ($M=3.25$, $SE=.20$). The difference is significant $t(11) = -3.46$, $p < .025$. Differences in the pre and post for curriculum did reveal a significant increase in the means $t(11) = -2.12$, $p > .025$.

The teacher candidates were also grouped according to their elementary mathematics methods instructor in order to address the influence of the instructor on teacher candidates' beliefs. For the fall 2011 semester, there were four elementary mathematics methods instructors. Two of the instructors are full time professors, one is a full-time instructor and doctoral student, and one is a part-time adjunct faculty and doctoral student.

Instructor A had 21 undergraduate teacher candidates enrolled in her section of elementary mathematics methods. Her candidates were placed with Amy, Brenda, Deb, Fran, and Linda. All three constructs for her students displayed a significant change. The teacher candidates' beliefs moved toward more constructivist views. The analysis is presented in Table 32.

Table 32

Analysis of Instructor A's Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	21	1.62	.02	1.77	.02	-5.49	.00
Learning	21	2.98	.10	3.46	.09	-3.85	.00
Efficacy	21	3.05	.18	3.40	.13	-2.31	.03

There was a significant difference in the pre and post mean scores for the curriculum section of the MBI. Teacher candidates moved toward more constructivist views about curriculum when comparing pre curriculum beliefs ($M=1.62$, $SE=.02$) to the post curriculum beliefs ($M=1.77$, $SE=.02$). This difference is significant $t(20) = -5.49$, $p < .025$ and represented a large effect size $r = .60$. Teacher candidates also experienced a significant change in beliefs about learning $t(20) = -3.85$, $p < .025$. This difference represented a medium effect size $r = .43$. Differences in the pre ($M=3.05$, $SE=.18$) and post ($M=3.40$, $SE=.13$) for efficacy did reveal an increase in the means, however the difference was not significant $t(20) = -2.31$, $p > .025$.

Instructor B had 23 undergraduate teacher candidates enrolled in her elementary mathematics methods course. Her candidates were placed with eight different university supervisors: Amy, Brenda, Cindy, Deb, Fran, Gina, Jill, and Linda. Instructor B's teacher candidates demonstrated a change toward more constructivist views in all three areas, however only two were significant. The analysis is found in Table 33.

Table 33

Analysis of Instructor Bs Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	23	1.65	.02	1.69	.22	-1.56	.13
Learning	23	3.01	.09	3.32	.08	-3.44	.00
Efficacy	23	2.91	.16	3.15	.15	-2.31	.03

Differences in the pre (M=3.01, SE=.02) and the post (M=3.32, SE=.08) for learning did reveal an increase in the means. This was a significant change in beliefs about learning $t(22) = -3.44, p < .025$. This difference represented a medium effect size $r = .35$. Differences in the pre (M=2.91, SE=.16) and post (M=3.15, SE=.15) for efficacy did reveal an increase in the means that was not significant $t(22) = -2.31, p > .025$. Teacher candidates did move toward more constructivist views about curriculum when comparing pre curriculum beliefs (M=1.65, SE=.02) to the post curriculum beliefs (M=1.69, SE=.02), however this change was not significant $t(22) = -1.56, p > .05$.

Instructor C had 19 MAT teacher candidates enrolled in elementary mathematics. These teacher candidates were placed with nine different university supervisors: Amy, Brenda, Deb, Emily, Gina, Helen, Jill, Kim, and Linda. Instructor C's teacher candidates exhibited significant change in beliefs for all three constructs of the MBI. The analysis is found in Table 34.

Table 34

Analysis of Instructor Cs Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	19	1.65	.11	1.80	.02	-5.83	.00
Learning	19	3.20	.54	3.61	.08	-3.73	.00
Efficacy	19	2.71	.90	3.42	.10	-2.89	.01

There was a significant difference in the pre and post mean scores for the curriculum section of the MBI. Teacher candidates moved toward more constructivist views about curriculum when comparing pre curriculum beliefs ($M=1.65$, $SE=.03$) to the post curriculum beliefs ($M=1.80$, $SE=.02$). This difference is significant $t(18) = -5.83$, $p < .025$ and represented a large effect size $r=.65$. Teacher candidates also experienced a significant change in beliefs about learning $t(18) = -3.73$, $p < .025$. This difference represented a medium effect size $r=.44$. Differences in the pre ($M=2.71$, $SE=.21$) and post ($M=3.42$, $SE=.10$) for efficacy did reveal an increase in the means that was significant $t(20) = -2.31$, $p < .025$.

Instructor D had 16 MAT teacher candidates enrolled in her elementary mathematics methods course. Her teacher candidates were assigned to ten different university supervisors: Amy, Brenda, Deb, Emily, Fran, Gina, Helen, Jill, Kim, and Linda. These teacher candidates did not have any significant change in beliefs. The analysis for Instructor Ds teacher candidates is found in Table 35.

Table 35

Analysis of Instructor Ds Teacher Candidates' MBI Scores

Construct	N	Pre MBI Mean	Pre MBI SD	Post MBI Mean	Post MBI SD	t score	p-value
Curriculum	16	1.65	.09	1.65	.31	.00	1.00
Learning	16	3.09	.49	3.27	.93	-.76	.46
Efficacy	16	3.03	.53	2.84	1.03	.68	.51

The mean scores for the pre and post for the curriculum construct remained the same ($M=1.65$), resulting in no change in beliefs. The pre ($M=3.09$, $SE=.12$) and the post ($M=3.27$, $SE=.23$) mean scores for learning reveal a positive increase toward more constructivist views about learning, however, this increase was not significant $t(15)=-.76$, $p>.025$. The pre ($M=3.03$, $SE=.13$) and the post ($M=2.84$, $SE=.26$) display a shift toward more traditional views regarding efficacy, this change in beliefs is not significant, $t(15)=.68$, $p>.025$. The individual responses of the teacher candidates are summarized in Appendix U; the pre-assessment scores are on top with the post-assessment scores below. One teacher candidate did not answer questions twenty-four through thirty. Highlights from individual questions are discussed.

The teacher candidates believe that K-5 students should share their thinking and approaches with other students. They believe that mathematics can be thought of as a language that must be meaningful if students are to communicate and apply mathematics productively. They believe that a goal of mathematics instruction is to help children develop the belief that they have the power to control their own success. The teacher candidates believe that mathematics instruction should incorporate other content areas, and that learning mathematics is an active process, and that good mathematics teacher

show students lots of different ways to look at the same question. The teacher candidates believed in mathematics you can be creative and discover things by yourself, and that math problems can be done in more than one way.

The teacher candidates experienced a change in several beliefs. At the beginning of the semester, 85% (n=66) of teacher candidates believed children should be encouraged to justify their solutions, thinking, and conjectures in a single way; this is in direct contrast to the 95% (n=74) of teacher candidates at the end of the semester who disagreed with this statement. Teacher candidates also changed their beliefs in regard to teaching the strands of mathematics in isolation. At the end of the semester only 8% (n=6) of teacher candidates believed the strands should be taught in isolation. On the pre-assessment MBI, 94% (n=73) of teacher candidates believed that there should be an increased emphasis on clue/key words, this is in contrast to only 56% (n=44) believing that at the end of the semester. The belief that learning mathematics is absorbed was held by 82% (n=64) of teacher candidates in the beginning and 64% (n=50) at the end of the semester. More teachers believed good reasoning should be regarded even more than students' ability to find correct answers on the post assessment.

When it comes to believing that certain populations are better with mathematics, 14% (n=11) of teacher candidates believe that males are better than females. While 18% (n=14) believe that some ethnic groups are better at mathematics than others.

The two questions about efficacy had some notable changes. At the beginning of the semester, 10% (n=8) of teacher candidates believed that they were not good at learning mathematics, at the end only 3% (n=2) of teacher candidates held this belief. Nineteen percent (n=15) of teacher candidates felt they were good at learning

mathematics in the beginning and that rose to 37% (n=29) on the post assessment. Those that have confidence in being very good at teaching mathematics rose from 25% (n=20) to 42% (n=33). One teacher candidate still believes that she/he will not be good at teaching mathematics.

Reformed Teaching Observation Protocol

All teacher candidates enrolled in elementary mathematics methods were assessed teaching mathematics to elementary students (grades K-5) in their field placements by their university supervisor using the RTOP. The RTOP is an observation tool used to assess reformed or standards based mathematics (and science) lessons. Observers rate twenty-five elements on a scale from 0 to 4. The highest possible score is 100; 50 or higher represents reformed-based teaching.

Each of the eleven supervisors was observed twice to test for accuracy and fidelity to the use of the instrument; the researcher and the university supervisor observed and assessed the same lesson. These scores are presented in Table 36. One supervisor failed to schedule two observations, and one supervisor only scheduled one observation.

Table 36

RTOP Comparison

University Supervisor	TC1 RTOP	Researcher	TC2 RTOP	Researcher
A	85	46	85	58
B	93	31	72	20
C	23	16	34	15
D	98	71	33	37
E	53	30	89	49

F	82	43	96	41
G	76	42	65	39
H				
J	86	76		
K	70	54	75	58
L	66	79	51	36

Using descriptive statistics the university supervisors' RTOP scores were analyzed. Table 37 displays a graph of the mean RTOP scores to provide a visual of the variation between the university supervisors.

Table 37

Comparison of University Supervisors' RTOP Scores

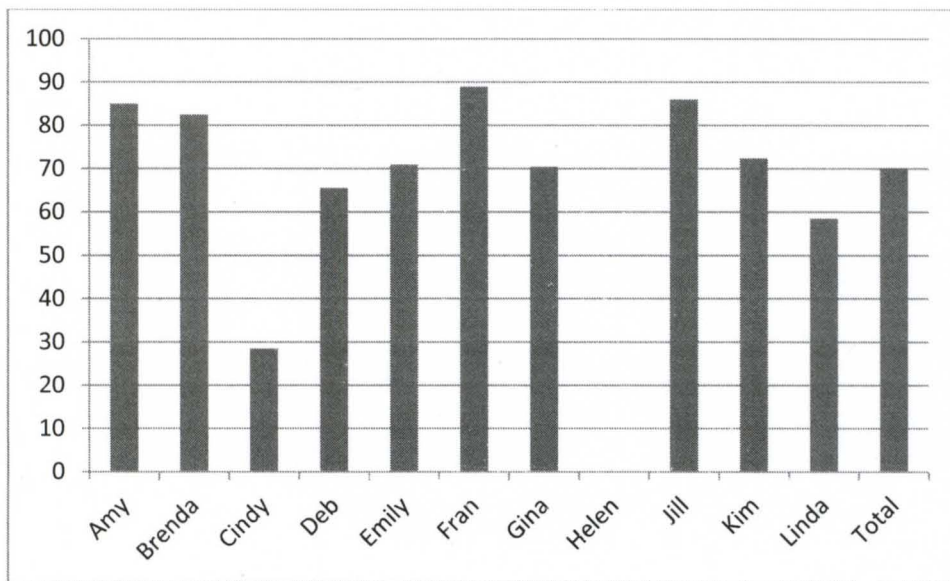


Table 38 displays a breakdown for each supervisor providing the mean and standard deviation. The total mean for all university supervisors was 70.10 with a standard deviation of 22.15.

Table 38

University Supervisor Descriptives

University Supervisor	N	Mean	SD	SE
Amy	2	85.00	.00	.00
Brenda	2	82.50	14.85	10.50
Cindy	2	28.50	7.78	5.50
Deb	2	65.50	45.96	32.50
Emily	2	71.00	25.46	18.00
Fran	2	89.00	9.90	7.00
Gina	2	70.50	7.8	5.50
Helen	0	NA	NA	NA
Jill	1	86.00	NA	NA
Kim	2	72.50	3.54	2.50
Linda	2	58.50	10.61	7.50
Total	19	70.12	22.15	5.08

In addition an independent paired samples t-test was conducted using SPSS. The SPSS output tables are found in Table 39. On average, teacher candidates received higher RTOP scores from the university supervisors ($M=70.11$, $SE= 5.08$), than from the researcher ($M=44.26$, $SE=4.26$). This difference was statistically significant $t(18) = 5.79$, $p<.05$; it represents a large sized effect $r = .65$.

Table 39

Paired Samples t-test Comparison

	N	Un. Sup. Mean	Un. Sup. SD	Researcher Mean	Researcher SD	t score	p-value
RTOP	19	70.11	22.15	44.26	18.58	5.79	.00

The University Supervisors

The university supervisors were the focus of the study. Each will be presented through portraits highlighting their backgrounds, beliefs about mathematics, coaching in the post-conference meetings with teacher candidates, and their support they provide to teacher candidates. These data were collected from the MBI surveys, the post-conference data, the interviews, and the RTOP forms. Names have been changed in order to maintain confidentiality and protect the identities of the participants of the study.

The post-conferences were transcribed, the university supervisors' dialogue was highlighted, and paraphrases were counted and questions were coded and counted. The researcher and another certified Cognitive Coach blind coded the types of questions asked by the university supervisors for reliability and fidelity to the codes. Coding matched for 124 questions out of 138 questions, with an inter-rater accuracy rate of 92%. A third Cognitive Coach was asked to code the fourteen questions that were not a match. Questions were identified as open-ended, mediating, probing, and closed. Additional categories were added to address the content of the question: content based, lesson planning, and behavior/ performance based.

Interviews were transcribed and coded to identify themes. The researcher and another mathematics educator coded and identified the themes. Then the interviews were organized and summarized.

Amy

Amy is a Caucasian, female educator who is both an instructor for the university and in her first year as a university supervisor. Amy has forty years of experience in education; thirty of those were teaching elementary school that included twenty years teaching mathematics. She holds a bachelor's degree, a master's degree for Reading Specialist and Diagnostician, in addition to thirty credit hours beyond her master's. Amy labels herself as an average mathematics student. She categorizes her supervision practice as being a "supervisor."

Amy supervised five teacher candidates enrolled in elementary mathematics methods during the fall 2011 semester. Amy observed four of her teacher candidates teaching mathematics. The fifth teacher candidate was observed by the cooperating teacher; this candidate has been omitted from the RTOP data as the cooperating teacher was not a part of this study. A summary of the RTOP scores for her teacher candidates is found in Table 40.

Table 40

Amy's RTOP scores

Teacher Candidate	RTOP Score
Teacher Candidate 1	88
Teacher Candidate 2	72
Teacher Candidate 3	89
Teacher Candidate 4	85
Teacher Candidate 5	No score
83.5 Mean	

Amy's approach to conferencing was to start very open with questions like, "What do you think?" and "What would you do differently?" She sparked reflection with mediating questions like, "What are some alternatives?" and "Can you brainstorm some possible ways to do that?" In one conference she only used two paraphrases and in the second she did not paraphrase. In the second conference she used eight closed ended questions and nine probing questions. Her closed ended questions included, "Were you assessing?" and "Did you observe different strategies?" In one conference, there was not a focus on the mathematics; in the second conference, there were three questions in regard to mathematics. These questions were about the different strategies that the students were using to solve problems. Within the same conference there were more questions about the lesson plan design and three questions about behavior. A summary of Amy's questioning and paraphrasing is found in Table 41.

Table 41

Amy's Conferences

Type of question	Conference 1	Conference 2
Open-ended	6	7
Mediating	4	1
Probing	0	9
Closed	4	8
Content specific	0	3
Behavior or Performance specific	2	6
Lesson planning	2	3
Paraphrases	0	2

In an interview, Amy described the support that she provided to teacher candidates as content execution, management, and pacing. She said she, “depended on the methods classes to provide the content and she focused on the management.” When asked how her practice changed this semester, she said that she listens more and does not dictate and tell the teacher candidates what to do. She said now, she questions the teacher candidates and has them come up with ideas and solutions. She has been surprised that “their ideas have been viable and productive.”

Amy felt the use of the RTOP was beneficial to her observation practice. She said without it her “expectations would have been much lower.” Amy had this to say about mathematics:

I felt so inadequate in math and I still do. I learned early on that I wasn’t any good in math. It’s the same story you hear from so many students, and until we change that perception of themselves I think no matter what we do we’re doing them a disservice until we can bring up a generation where nobody says I’m bad at math.

Amy had the teacher candidates go through each indicator on the RTOP during the conference, however, she then gave her assessment. She has found the self-reflection beneficial to the teacher candidates, and the process provided her a way to evaluate critically. Amy added this comment about the RTOP, “I think some of the criteria on the RTOP are not appropriate for the majority of the lessons, at least in my opinion.” Because of the RTOP training, Amy said that she now looks for a “thought, process driven lessons rather than practice and drill driven lessons.” She also stated she expects them to get the children to connect with different strategies. She said she sees the value of student centered and to a point a master teacher can teach that way, however she does not

see how that is possible day to day. Amy said “that mathematics was easier for them to execute a lesson this year. It didn’t seem to be as much of a challenge. They were more confident.”

In her role as an elementary university supervisor, Amy shared that she is uncomfortable being the bridge between the university and the field placement school. She does not see it appropriate for her to “step on toes” and talk to the cooperating teachers about assignments and expectations. She stated that the methods instructors should provide the information, expectations, and support to cooperating teachers. Amy found the professional development helpful. She summed it up by saying,

It was affirming. It held me accountable and I was forced to change some of my habits. And unfortunately if we (university supervisors) aren’t held to be accountable in some way, we just keep on doing the same thing because it’s comfortable. And it’s been interesting for me to hear the other supervisors’ discussions of their practices and that’s been extremely helpful as well.

Brenda

Brenda is a Caucasian, female with thirty-four years of experience as a teacher. She primarily taught fifth grade. Brenda has two years of experience in her role as a university supervisor. She classifies herself as a high achieving student of mathematics. She labels her supervision practice as both “coach” and “collaborator.” Brenda has had previous training in coaching/ mentoring prior to this study.

Brenda was assigned ten teacher candidates enrolled in the elementary mathematics methods course. She observed nine of them using the RTOP. The tenth one she allowed the cooperating teacher to observe; as in the other case, this student was

pulled from the sample. Brenda's RTOP scores range from 64-93. A summary of Brenda's scores are found in Table 42.

Table 42

Brenda's RTOP Scores

Teacher Candidate	RTOP Score
Teacher Candidate 1	74
Teacher Candidate 2	73
Teacher Candidate 3	87
Teacher Candidate 4	72
Teacher Candidate 5	76
Teacher Candidate 6	76
Teacher Candidate 7	64
Teacher Candidate 8	69
Teacher Candidate 9	93
Teacher Candidate 10	No Score
76 Mean	

Brenda's format for the post-observation consisted of asking a few questions and then reading the RTOP to the teacher candidate. She began the first conference with a probing question: "How did you decide your objective?" She began the second conference by just asking an open-ended question, "Impressions?" She used more probing questions and closed ended questions verses mediating questions. Brenda asked mostly probing questions: "How did you decide your objective?" "Prior to this, what were the strategies with division?" Brenda's focus for the two conferences was more

about lesson planning and behavior versus a focus on the mathematics. In the first conference, Brenda did ask one probing question about the mathematics that was mentioned above: “Prior to this, what were the strategies with division?” and she asked one closed question: “So is 25 divided by 7 new for them?” She also did not paraphrase in either of the conferences. Brenda would lead a short conference with the teacher candidates and then move to the discussion of the RTOP. Brenda would read the RTOP and have the candidate score themselves as a self-assessment; Brenda did not score them prior to this conference. Brenda never disagreed with the teacher candidates. She gave them the score that the candidate assigned and agreed with their justification. If the teacher candidate could justify the indicator, Brenda would agree. A summary of Brenda’s questions are found in Table 43.

Table 43

Brenda’s Conference

Type of question	Conference 1	Conference 2
Open-ended	1	1
Mediating	1	0
Probing	4	2
Closed	5	2
Content specific	2	0
Behavior or Performance specific	3	0
Lesson planning	1	2
Paraphrases	0	0

When interviewed, Brenda found the professional development to be really valuable. She said she still needs to apply more of the strategies, because she still wants to “tell them (the teacher candidates) what to do.” She said that she tries to question more, but finds that it is really hard. She added that she knows where she wants the teacher candidates to go in the conference and that some look to her for answers. She concluded, “Yeah, I’m still trying and that is definitely not a strength.” Brenda would like to continue the professional development. She said, “It’s kind of nice when a group of university supervisors come together. Most of us have the same issues, so it is nice to hear what other university supervisors would do.”

Brenda believed the RTOP to be an excellent observation tool. She called it a little bit scary for the teacher candidates who are perfectionists. She shared with her teacher candidates which of the main descriptors to focus on in order to “try to not overwhelm them.” She did not specify which ones were the main descriptors.

Brenda described the support that she provides to the teacher candidates in the teaching of mathematics. She said she tells them to “include manipulatives.” Brenda wanted the teacher candidates to have students explain their thinking and to give proper wait time. Brenda shared what she looks for in a mathematics lesson, she wants to see manipulatives, questioning strategies, and real world connections. Brenda also shared that she thinks the teacher candidates are “well trained by the best in the country” referring to the methods professors.

Brenda has not been a bridge between the university and the field placement schools. She shared that both of the schools that she works with are excited and welcome the university students. The advice that Brenda gives to teacher candidates when they see

teaching that does not match what they are learning, is that she encourages them to offer to teach more, so they can share and expose the cooperating teachers to the program expectations. She also has encouraged the teacher candidates to lead professional development for the teachers on the use of the Smartboard.

Brenda described her own teaching of mathematics as hands-on and problem solving based. She said she used lots of games and manipulatives when she taught. Teaching mathematics was her favorite subject to teach, and she sought out opportunities to learn more about improving her mathematics instructional practice.

Cindy

Cindy is an African American, female with forty years in the field of education. For thirty-three years of her experience she was an elementary school teacher. Cindy has both a bachelor's and master's degree. This is her first year in the role of university supervisor. She labels herself as a high achieving mathematics student. She identifies her supervision practice as that of "coach." Cindy has had previous training in coaching/mentoring prior to this study.

Cindy was assigned six elementary mathematics methods teacher candidates. Cindy's RTOP scores ranged from 23-50. The average RTOP scores of Cindy's teacher candidates was 38 as displayed in Table 44.

Table 44

Cindy's RTOP Scores

Teacher Candidate	RTOP Score
Teacher Candidate 1	44
Teacher Candidate 2	34
Teacher Candidate 3	37
Teacher Candidate 4	40
Teacher Candidate 5	50
Teacher Candidate 6	23
38 Mean	

Cindy led two conferences that included a variety of questions and topics. She began the first conference with an open question, “Talk about the beginning, middle, and end of your lesson.” The other conference began with a probing question, “Tell me about your objectives.” She used a variety of mediating questions to encourage reflection for example, “What other strategies could be used?” and “How could you use those strategies in the modeling to make choices?” Cindy focused on the content of mathematics by asking questions about strategies, students’ prior learning, and connecting the content to the real world. She also addressed student understanding of the mathematics with a question, “I noticed a student saying, make sure you put the bigger number first, what could you do to address this?” This question also addresses the teacher candidate’s understanding to be able to address this student’s misconception. In addition, Cindy asked some closed ended questions to further assess the teacher candidate. She asked her, “If you say put together, what is the answer called?” The teacher candidate answered,

“Sum.” Cindy next asked, “What’s the answer to a subtraction problem?” The teacher candidate could not answer. Cindy had to tell her, “Difference.” Cindy then provided her with two scenarios. Cindy’s focus was on the mathematics content knowledge and the preparation of quality lesson plans that included having and knowing the objectives, and having an assessment plan. A summary for her two conferences is found in Table 45.

Table 45

Cindy’s Conference

Type of question	Conference 1	Conference 2
Open-ended	6	6
Mediating	3	3
Probing	3	3
Closed	6	7
Content specific	7	6
Behavior or Performance specific	0	1
Lesson planning	6	6
Paraphrasing	1	1

Cindy found the professional development to be life changing. She said she will never lead a post-conference the same way again. Cindy said this about the collection of sessions, “It’s definitely impacted the way I relate to the students, because in the past I definitely would ask questions, but not in such a way as to, you know, guide their thinking.” She questioned teacher candidates before, but in a way to guide their thinking. She said she will never go back to the old approach she used. She also stated:

I feel that that out of all the training that I've had in a long time, this has been one of the most valuable that I could possibly have, and I'll have to keep revisiting it (the materials and ideas). So, it's really had a big impact on the help not just with the university students that I work with, but with the teachers I also work with.

When it came to the RTOP, Cindy said she was uncomfortable using it at first. She could not see how it fit with the teacher standards. However, the more that she used the RTOP she said she realized that "it got to the heart of what we expect from our teacher candidates in teaching mathematics." She said it requires more critical thinking. Cindy found the RTOP helpful in being able to provide feedback. She had this to say:

It has helped me as I observe, and it helps me when I give the feedback to the teacher candidate. So that I can help guide their progress, and guide them in areas where they need to make sure students are being taught the right skills.

Cindy had several things that she looks for in a mathematics lesson. She shared that she watches for student engagement and problem solving. She said that she "pays attention to how they (teacher candidates) introduce and monitor the work." She stated that she wants to see them listening to the students, questioning, and making adjustments based on the dialogue. She also shared that she wants to see how they address misconceptions held by the students, and their assessment plan. She also expects to see a closing.

As Cindy reflected on the support that she provides to candidates, she wishes she had done more. This is her first year as a supervisor, so she felt that she could have guided them more. She said she did give them questions to answer and look for to include

in their weekly reflections, but wishes she would have been even more aligned with the assignments from their methods courses.

When bridging the university expectations and the field placement teaching, Cindy said she used conversations with the classroom teachers. She shared a strong respect for the cooperating teacher and practice, as she had been a cooperating teacher numerous times when she was still in the classroom. She approached the question of providing a bridge between the university and field placement by stating that “if the lesson is well planned then the benefit of teaching it will be obvious to all.” She cautioned that the schools and teachers are doing a service to the university, so we have to handle disagreements with the “utmost care.”

When Cindy was an elementary classroom teacher, she used a variety of strategies. She shared that she absolutely loved teaching math. She shared that the students always had manipulatives and participated in group activities. She said she has always been a hands-on teacher. She also tried to make the learning real world and meaningful.

Deb

Deb is a Caucasian, female with twenty-nine years of experience as a teacher and thirty-nine years total in education. Deb has both her bachelor’s and master’s degree. She has an additional thirty hours above her master’s. Her certificates include elementary education and a gifted and talented endorsement. For nine years, Deb has been a university supervisor. She classifies herself as an above average to average mathematics student. She classifies her role as a “coach” and “mentor.”

Deb supervised twelve teacher candidates during the fall 2011 semester. Her RTOP scores ranged from 33 to 98. Her average RTOP score was 70.58 as summarized in Table 46.

Table 46

Deb's RTOP Scores

Teacher Candidate	RTOP Score
Teacher Candidate 1	98
Teacher Candidate 2	83
Teacher Candidate 3	70
Teacher Candidate 4	81
Teacher Candidate 5	73
Teacher Candidate 6	69
Teacher Candidate 7	78
Teacher Candidate 8	82
Teacher Candidate 9	60
Teacher Candidate 10	33
Teacher Candidate 11	56
Teacher Candidate 12	64
70.58 Mean	

Deb began the first conference with paraphrases, as the teacher candidate came in talking about the lesson. Deb paraphrased back twice, then proceeded to ask open-ended questions such as, “Anything else you thought?” and “What was something you liked?” Once she started with questions, she no longer paraphrased for the teacher candidate. She

did ask numerous questions about the mathematics. These include: “Let me ask about symbols, are they familiar to the students?” and “What is the difference between taking 8 from 10, and taking 8 cents from 10 cents?” She asked one lesson planning question. She asked the teacher candidate to elaborate on what she forgot from her plan. Deb’s second conference included more paraphrases and more open-ended questions. For this conference she also addressed the mathematics by having the student elaborate on why she believed the students needed more elaboration and practice. She also inquired about the benefit of modeling the mathematics on the Smartboard. Another element of mathematics that she addressed was the essential vocabulary of the lesson and how to incorporate the vocabulary to get the students more familiar with using the vocabulary. A summary of Deb’s conferences is found in Table 47.

Table 47

Deb’s Conference

Type of question	Conference 1	Conference 2
Open-ended	4	5
Mediating	0	1
Probing	0	1
Closed	5	6
Content specific	5	3
Behavior or Performance specific	1	0
Lesson planning	1	1
Paraphrases	2	9

Deb found the professional development to be a positive addition to the work of the university supervisors in the elementary education program. She referenced that there had been support similar in past years, but that it had gone away. She found the coaching strategies helpful in fostering reflection. Deb stated:

The coaching strategies allow me to help the student dig deep and really think about their teaching, letting them arrive at insightful conclusions. The coaching strategies are effective for all content areas.

She also said that she has come to “believe the strategies expected in the RTOP”. She now has different expectations for the mathematics lessons. Deb said that reflection was not something she used to expect in a lesson and now she expects the teacher candidates to have the students reflect on their learning. She shared that she “always expected to see connections to real life, prior learning, using manipulatives, drawings, organizers, tools, more than one way to solve problems, sharing ideas, justifying, etc.” She closed with saying she did not usually see them all in one lesson, though.

Deb is not comfortable addressing disconnects between the university and the field placement. She said that the “schools are locked into one way of doing things and that the expectations are clear and non-negotiable.” She does not feel like the person to question or address the differences. She said she provides the support to the teacher candidates in making the best with both worlds.

Deb taught mathematics as an interactive learning process when she was a classroom teacher. She used manipulatives and group instruction. She taught with problem solving and strategies.

Emily

Emily is a Caucasian, female with twenty five years as an educator. She holds a PhD, Language, Literacy and Culture Early Childhood/Elementary Education. She has ten years of experience as a university supervisor at another university. This is her first year in the role at this university. She spent ten years teaching mathematics in her role as an elementary teacher. She labels herself as a high performing mathematics student. She sees her supervision practice as that of “coach.”

Emily supervised six teacher candidates who were enrolled in elementary mathematics methods during the fall 2011 semester. The RTOP scores of her teacher candidates ranged from 53 to 90, with the average being 80.8. A summary of the scores is found in Table 48.

Table 48

Emily's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	85
Teacher Candidate 2	53
Teacher Candidate 3	89
Teacher Candidate 4	90
Teacher Candidate 5	89
Teacher Candidate 6	79
80.8 Mean	

Emily began both conferences with a similar open ended question, “So, how do you feel?” and “What did you think?” She asked some mediating questions in the first

conference that included, “What are some of your goals?” and “What were other things that stuck out to you?” Emily did include questions about the mathematics content of the lessons. One of the teacher candidates had three different mathematics topics included within her single lesson. Cindy asked the teacher candidate, “Do you think it was mathematically aligned?” Another question was about a student, “So your thoughts about when the girl asked about subtraction?” In both post conferences Emily did ask questions about the lesson planning that included comparing the teaching to the lesson plan. She also asked specific questions about individual students in both conferences, and in the second conference student behavior was a major issue. Emily only asked one question about this, however, she did talk about it for a considerable amount of time with the teacher candidate. A summary of Emily’s conferences is found in Table 49.

Table 49

Emily’s Conference

Type of question	Conference 1	Conference 2
Open-ended	2	6
Mediating	6	0
Probing	1	1
Closed	7	2
Content specific	2	2
Behavior or Performance specific	2	3
Lesson planning	2	3
Paraphrases	3	1

Emily believed the professional development to be beneficial in providing expectations for the post-conference. She said it provided a framework for what the university supervisors should be doing and what the purpose of the post-conference should be. She said it provided a “structure for dealing with the teacher candidate who just taught an okay lesson,” it gave her a mechanism for pushing reflection and critical thinking. She shared her experience as a university supervisor at another university, where an instructor who was a representative from each content methods course provided professional development. She envisioned this program change to start the process of providing that kind of content support. She said that the professional development is an “opportunity to have a support group for those in a similar role.”

Emily shared that she used the RTOP in previous research. She said that it also reminded her of the work she had previously done with Cognitively Guided Instruction (CGI) (Carpenter & Fennema, 1991). She said she referred to the RTOP to keep her focused on high quality mathematics instruction. She said when she observed the mathematics lesson that she always had the RTOP with her. When observing, Emily wants to see dialogue and problem solving. She wants to see and hear student thinking. She attributed these attributes to mathematical teaching to the concepts of CGI, and not necessarily the RTOP.

One of the ways that Emily provided support to her teacher candidates was to proof the lesson plans 24 hours in advance. She said her teacher candidates were very conscious of the expectations of their methods instructors and she had to provide support for the difference in teaching at the field placement school. She shared that they had many discussions about the real world versus the “ideal” in their weekly meetings. She

wants her teachers to “not think in terms of right or wrong, but find the value in the instructional decisions.”

Emily did not address how she provides a bridge and support between the university and the teacher candidates directly. She responded by saying that she works with the teacher candidates to plan their lessons trying to make both parties happy. She called them “scaffolded conversations.”

As an early elementary teacher, Emily used *Math Their Way* (Baratta-Lorton, 1988). She incorporated manipulatives, inquiry activities, and dialogue. She also attended professional development to increase the level of questioning that she was using in her teaching. Her partner teacher was involved in the CGI, so Emily also incorporated that philosophy into her teaching.

Fran

Fran is a Caucasian, female with forty-one years in education; thirty-three years were teaching in K-12 schools. For twenty-seven years Fran taught mathematics in the elementary school. Fran has a bachelor's and master's degree. She also has thirty hours above her master's in school administration. Fran has been a university supervisor for eight years. She labels herself as an average mathematics student. She classifies her supervision practice as “collaborator.” Fran has had previous training in coaching/mentoring prior to this study.

Fran supervised eleven teacher candidates who were enrolled in elementary mathematics methods. Her RTOP scores on teacher candidates ranged 68 to 100, with the average being 90.7. One teacher candidate was observed by her mentor teacher; this candidate's RTOP data was eliminated from the study. Fran's strategy for the RTOP was

to review each indicator with the teacher candidate and allow them to reflect and assess themselves. This practice may explain the high percentage of scores from 90-100. A summary of Fran's RTOP scores are found in Table 50.

Table 50

Fran's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	93
Teacher Candidate 2	100
Teacher Candidate 3	84
Teacher Candidate 4	88
Teacher Candidate 5	100
Teacher Candidate 6	96
Teacher Candidate 7	100
Teacher Candidate 8	96
Teacher Candidate 9	82
Teacher Candidate 10	68
Teacher Candidate 11	No score- cooperating teacher observation
90.7 Mean	

Fran began both conferences with an open-ended question. The first question for conference one was, "How do you think it went?" and the question for the second conference was "As you reflect, what do you think?" The first conference was shorter than the first, because Fran had to get to another meeting. So Fran asked a question immediately after the teacher candidate answered the previous one. The questions were

not connected. Her last question for this conference was a closed question “Is there anything that you would change?” The second conference Fran connected the questions and seemed to have more of a focus on the lesson planning. She asked specific questions about the use of technology and assessment. She asked probing questions about the cooperating teacher and organization. She ended the conference by stating what the teacher candidate needed to work on for next time. A summary of Fran’s conferences is found in Table 51.

Table 51

Fran's Conference

Type of question	Conference 1	Conference 2
Open-ended	2	9
Mediating	0	5
Probing	1	4
Closed	4	2
Content specific	1	0
Behavior or Performance specific	2	1
Lesson planning	2	3
Paraphrase	1	0

Fran found the professional development to be extremely helpful. She said that the coaching training “gave her more to talk about in a more professional way.” She said that it slowed her down, because she was used to just telling them what to do and not giving the teacher candidates time to process.

Fran found that the RTOP made her “more aware of the expectations for mathematics teaching.” She said that she learned that the “teacher candidates should be using manipulatives;” Fran did not know that it was an expectation of methods that the teaching should be interactive. She also realized they should engage the students prior to teaching, and that there should be a beginning, middle, and end. She became more cognizant of what a mathematics lesson should include and “found the specifics (of the RTOP) very helpful.”

Fran’s support for the teacher candidates came in the form of conversations. She said her approach was to just ask them what they needed. She said she would find them manipulatives or resources when they needed something for a lesson.

In her role to provide a bridge the university expectations and the field placement school, Fran said that “they discuss it, but ultimately the teacher candidates have to do what the cooperating teacher wants.” She did have her teacher candidates learn the new mathematics program at one of her field placement schools and lead an informational family night.

When Fran taught elementary mathematics, she said she did a lot with manipulatives because she struggled in math herself, and she wanted to meet the needs of all students. This is a surprise since she did not expect teacher candidates to use them prior to the professional development. She said she taught to the middle of the class and was challenged to meet the needs of the advanced students. She said she was not aware to have the three parts of a lesson.

Gina

Gina is a Caucasian female. She has twenty-two years in education that include twelve years of elementary teaching. During those twelve years, her teaching included mathematics. Gina has been a university supervisor for nine years. Both her bachelor's and master's degrees are in elementary education. She labels herself as an above average mathematics student. She classifies her supervision practice as "supervisor."

Gina supervised five elementary mathematics methods teacher candidates during the fall 2011 semester. Gina's RTOP scores range from 55-80 with the average of her scores being 68 as presented in Table 52. One candidate was observed by the cooperating teacher, so this RTOP score is not included.

Table 52

Gina's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	55
Teacher Candidate 2	61
Teacher Candidate 3	80
Teacher Candidate 4	76
Teacher Candidate 5	No score – cooperating teacher observation
68 Mean	

Gina began both conferences with an open ended invitation to teacher candidates to "Tell me about your lesson." The first conference was quite different from the second. The first conference was dominated by Gina doing all of the talking. She only asked a total of nine questions. None of them were about mathematics. The majority focused on

lesson planning; topics included transitions, groupings, and timing. Her dialogue consisted of sharing what to do, such as telling the candidate, “Stop and put in some interventions. Get with the counselor and talk about the discrepancy in levels.” Gina’s second conference was remarkably different. While she still shared numerous ideas, she asked more open ended questions and paraphrased. She asked, “What did you like about the lesson?” and “What do you need to do to make that happen?” She also asked about the mathematics; she wanted to know what the students’ experience was with the division sign. Her primary focus was still on the lesson planning, because the focus was about the worksheet development, goals, and follow-up. For behavior, Gina asked about non-verbal cues and addressing advanced students. She ended both conferences by paraphrasing goals for the teacher candidates. A summary of Gina’s two conferences is found in Table 53.

Table 53

Gina’s Conference

Type of question	Conference 1	Conference 2
Open-ended	4	8
Mediating	0	1
Probing	3	4
Closed	2	3
Content specific	0	1
Behavior or Performance specific	1	2
Lesson planning	4	5
Paraphrases	1	5

Gina spoke highly of the professional development. She said that her support to teacher candidates changed by devoting more time to dialog. She felt she did not talk as much and does not want to control the conversation like she did prior to the training. She said before she identified with the “supervisor” role, and then this semester she told the teacher candidates that she was their “coach,” there to encourage and cheer them on. Gina found the paraphrasing and questioning helped to give the teacher candidates more control in the post-conference. She said she “learned to guide and focus them with the paraphrasing and questioning”. She did find this addition to her conferencing hard when time was limited.

Gina found the RTOP helped her be more specific with what she expected in a lesson. She expected the teacher candidates to be more of a facilitator and listener. She said she “felt bad when the teacher candidates scored low on something, especially when the lesson did not lend itself to that descriptor.”

Gina facilitated weekly meetings with her assigned teacher candidates. Each time they would have a different topic. She said mathematics was the topic twice during the semester. She did follow-up with teacher candidates after those meetings to see what was happening in mathematics and ask follow-up questions. She mainly provided mathematical support during the post-conference.

Gina said that providing a bridge between the teacher candidates and the cooperating teachers is a “big role” that she does. The teacher candidates let her know when there is an issue through weekly reflections. Gina said, “I always tell my students that if you’ve got some issues then you need to voice those, so those reflections really

help me to diffuse issues.” She also has meetings with the cooperating teachers to keep the lines of communication open and defuse any issues.

Gina taught elementary school for twelve years. She said that she taught mathematics moving from the concrete to the abstract. She taught using manipulatives, especially base-ten blocks. She felt that she was too controlling instead of being more of a facilitator. She wished that she would have made more connections to the real world. She also incorporated a problem of the day. She tried to be well-rounded by incorporating technology and a variety of strategies with some integration of problem solving.

Helen

Helen is a Caucasian female with thirty-one years of experience in education. She has a bachelor’s degree in elementary education and a master’s degree in neurologically impaired and learning behavior disorders. She has been a university supervisor for three years. She taught for twenty-seven years and her classroom teaching included mathematics. She identifies herself as a below average mathematics student. She classifies her supervision practice as that of an “evaluator” and “collaborator.”

Helen supervised four elementary mathematics teacher candidates during the fall 2011 semester. The RTOP scores range from 73-92. The mean score is 81. One teacher candidate was observed by the cooperating teacher, so this candidate’s data were removed from the RTOP data. Helen’s scores are summarized in Table 54.

Table 54

Helen's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	73
Teacher Candidate 2	92
Teacher Candidate 3	78
Teacher Candidate 4	No score – cooperating teacher observation
81 Mean	

While Helen participated in the professional development, pre-and post-assessments, and the culminating interview, she did not participate in the observations. Having only three teacher candidates posed a problem for scheduling.

In an interview, Helen said that the professional development changed the way that she questioned the teacher candidates. She said the “RTOP helped inform her of the expectations of mathematics methods.” Helen said that however most of her post conferences for the semester were focused on classroom management. She said that there were a lot of problems, so the focus was not on the mathematics content. She shared that some of the descriptors on the RTOP were hard to assess and understand. She said, “I do think I was one of those who had a hard time understanding some of the numbers (on the RTOP), especially how would they state it.”

Helen shared her expectations for a mathematics lesson. She wanted to see easy explanations, hands-on, and technology. She said she also expected the teacher candidates to have students demonstrate what they have learned. She said that the RTOP did not impact her observations and expectations. Her words were, “it didn’t.”

Helen felt that she does not have a role in bridging the expectations of the university and the field placement schools. She said that there is really no way for her to help. She felt that the methods instructors could adjust some plans to make it easier on the teacher candidates.

Helen said she was a terrible math teacher when she was in the classroom. She accredits this to her own fifth grade teacher who told her mother that she would never make it through high school. She said she taught it the “old way” with no manipulatives. She said that she does not like manipulatives. She repeated that she does not like it and said she “shys” away from it as much as she can. She did share that today it is important for students to use manipulatives, learn the basics, and know more than one way.

Jill

Jill is a Caucasian female. Her experience includes sixteen years of teaching. Ten of those years include teaching mathematics while she was an elementary school teacher. She holds an Ed. D. in Curriculum and Instruction with an emphasis in Instructional Improvement. She has a reading and writing endorsement and is certified to teach both elementary and special education. Jill has been a university supervisor for seven years. She classifies herself as a high performing mathematics student.

Jill supervised five teacher candidates enrolled in elementary mathematics methods. The range of the RTOP scores was from 64 to 85. The average of Jill’s RTOP scores was 75.2. A summary of Jill’s RTOP scores is found in Table 55.

Table 55

Jill's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	79
Teacher Candidate 2	85
Teacher Candidate 3	64
Teacher Candidate 4	80
Teacher Candidate 5	68
75.2 Mean	

Jill was only observed once. Jill avoided the observations and finally scheduled one observation on December 12, 2011. The post-conference lasted only ten minutes. The conference began with an open ended question, “How do you think the math lesson went?” She followed with, “What are the strengths of the lesson?” Jill attempted two paraphrases: “So it sounds like the third graders are okay with the fourth grade math?” And “So you think the strategies helped, how did it help?” With both of her paraphrases, she added a question. Jill gave only one feedback statement, “I loved how the kids got to explore different strategies.” The conference ended with Jill looking at the researcher and asking, “Is there anything else that you would like us to talk about?” A summary of the types of questions used in Jill’s conference is found in Table 56.

Table 56

Jill's Conference

Type of question	Conference 1
Open-ended	5
Mediating	1
Probing	0
Closed	4
Content specific	1
Behavior or Performance specific	2
Lesson planning	0
Paraphrases	2

Jill's interview was short compared to all the other supervisors and took only ten minutes. She did not elaborate or express an interest in participating in the interview. The conversation revealed that Jill felt that her support of the teacher candidates did not change because of the professional development. She said she did not feel she was "good at it," but she should have done the coaching more to increase the reflection of the teacher candidates. She said in the beginning of the semester, teacher candidates were not ready to reflect and have these types of conversations. She said she did try to ask more open ended questions. She added if they did not answer what she wanted, she told them the answers. Jill did like the idea of professional development especially thinking about the new Common Core Standards(CCSSO, 2010), because they are new and the university supervisors have not had training or support since the state adopted the standards in 2009.

Jill said that the RTOP did not change what she looked for in a lesson. She said she always focuses on the teacher standards. She said that the RTOP helped her think about “critical thinking” when it came to the lesson.

Jill said the biggest support that she provides to teacher candidates is with cooperative learning strategies. She met with all of her teacher candidates to explain the process of including cooperative learning. She shared with them the importance of accountability and assessment. She also provided them with resources like books about topics of interest or concern. Although asked, she did not mention any specific mathematical support.

The only time that she has had to bridge the work of the university with the placement, was in regard to classroom management. She said other than that she has not had to step in.

Kim

Kim is a Caucasian female. She has a bachelor’s degree in elementary education, a master’s degree in elementary science. Her thirty hours above her masters are in mathematics and technology. Kim has thirty-four years of teaching experience that included the teaching of mathematics at the elementary level. Kim has been a university supervisor for three years. She identifies herself as an above average mathematics student. She classifies her supervision practice as “supervisor.” Kim has had previous training in coaching/ mentoring prior to this study.

Kim supervised four teacher candidates enrolled in elementary mathematics during the fall 2011 semester. Her RTOP scores ranged from 78 to 87. Her average RTOP score was 83.75. A summary of Kim’s RTOP scores are found in Table 57.

Table 57

Kim's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	78
Teacher Candidate 2	87
Teacher Candidate 3	83
Teacher Candidate 4	87
83.75 Mean	

Kim began both conferences with an open-ended invitations asking, “How do you feel?” and “Tell me about your lesson”. In the first conference, she paraphrased three times; one example was when Kim paraphrased, “I hear you saying that you will find new strategies.” The teacher candidate was focused on the small group activity and that was the focus of the whole conversation. There was no focus on the mathematics. A mediating question to get her to reflect was “What are some thoughts (about the struggle and nervousness) about (using) the small group instruction?” Kim’s second conference used more open-ended questions. She also asked specific questions about mathematics. These questions included, “What was the students’ experience with the number line?” and “What strategies did you use to elevate the mathematical thinking?” The questions related to behavior were in regard to one particular student. The lesson planning questions pertained to assessment and changes the candidate would make. A summary of Kim’s conferences is found in Table 58.

Table 58

Kim's Conferences

Type of question	Conference 1	Conference 2
Open-ended	1	5
Mediating	1	1
Probing	1	2
Closed	0	0
Content specific	0	2
Behavior or Performance specific	1	2
Lesson planning	1	4
Paraphrases	3	2

Kim really enjoyed the professional development. She liked the support that she received including the observations and follow-up session. She said that it makes sense to have training for the university supervisors, because the university is “requiring them to do observations but the grades come from the instructors, so the university supervisors need to know what is expected.” Kim said that the professional development overall did not cause her to change, but added that she does try to listen more. She called it “intentional listening”. Kim stated:

I’ve been more intentional about the way that I have answered or tried to guide them, and reframe and refocus and restate what they are saying to help them to understand what further guidance that they might need or changes that they may need to make or what they think about doing their next lesson.

Kim found the RTOP to be consistent with her expectations prior to the professional development. The exception was the rigor. Kim stated she had to give a lot of thought to the mathematical rigor of a lesson. She said sometimes the first day of a two day lesson may have less rigor than the second day.

Kim described her support as developmental. She said she has to assess the level of each teacher candidate in order to determine the needs and strengths. She stated that she did not “want to overpower their thoughts in a conference.” She said that when a student was adamant about trying something she let them; she wanted them to learn from their own success and mistakes. She said when she could she would provide guidance and offer suggestions, but she really had to make those decisions based on their needs.

Kim did a lot to provide a bridge between the university and the field placement schools. She co-taught lessons and modeled lessons. She previewed lessons before they were taught and made suggestions for improvement. She required all of her teacher candidates to learn the Smartboard. Because she has been university supervisor at the same school for three years, the teachers know her expectations and what to expect from the students. Kim said because she requires her teacher candidates to use technology, more of the teachers are using it as a result. She said that she is there to support the efforts of the university and does what she can to provide that service.

Kim said when she taught elementary school she taught integrated math. She said it was holistic with the incorporation of literacy and writing. She said it was high level for kindergarteners. She included both whole group and individual assistance. She taught the fundamentals, strategies, and problem solving. Kim was a member of NCTM when she was in the classroom and attended many conferences. She was one of the first trained in

the *Box It Bag It* program. Kim concluded saying math and science have always been a strength of her teaching.

Linda

Linda is a Caucasian female. She has forty-one years' experience in education. Thirty-one years were spent teaching elementary school; her teaching responsibilities included the teaching of mathematics. During that time, Linda was a member of the National Council of Teachers of Mathematics. She labels herself as an average mathematics student. She classifies her supervision practice as that of a "coach." Linda has had previous training in coaching/ mentoring prior to this study.

Linda supervised ten teacher candidates enrolled in elementary mathematics methods in the fall 2011 semester. Linda's RTOP scores ranged from 45 to 82. The average of Linda's RTOP scores was 61.78. A summary of Linda's RTOP scores is found in Table 59.

Table 59

Linda's RTOP Scores

Teacher Candidate	RTOP
Teacher Candidate 1	64
Teacher Candidate 2	77
Teacher Candidate 3	66
Teacher Candidate 4	55
Teacher Candidate 5	82
Teacher Candidate 6	69
Teacher Candidate 7	51

Teacher Candidate 8	45
Teacher Candidate 9	47
Teacher Candidate 10	73
<hr/>	
61.78 Mean	

Linda began both conferences with similar open-ended questions, “What do you think?” and “Think, and tell me what you think.” She used other open ended questions that included, “Why do you think that?” and “What did you like?” Linda only used a few mediating questions. These included, “So, what could you do to work on their responsibility?” and “What could you do as you think of future lessons?” Linda did not ask any questions pertaining to mathematics content or the teaching of mathematics. Her primary focus was on lesson planning. She asked several questions of the two teacher candidates that include, “How can you make yourself aware of time?” and “What parts of the assessment will you use?” The questions she asked about behavior included learning more about a group copying their work and another group that had gotten off task. Linda’s conferences are summarized in Table 60.

Table 60

Linda's Conferences

Type of question	Conference 1	Conference 2
Open-ended	3	2
Mediating	6	1
Probing	5	4
Closed	2	2
Content specific	0	0

Behavior or Performance specific	3	2
Lesson planning	7	5
Paraphrases	3	3

Linda appreciated the professional development. It reminded her of when the university used a Professional Development School Model (PDS) and had a focus on professional development for the cooperating teachers and university supervisors. She believed the professional development to be beneficial in providing her with tools to have “more effective conversations with the teacher candidates.” Linda found the RTOP to provide specifics for what was expected in a mathematics lesson. She liked having it as a resource to facilitate conversations. Linda especially benefited from the practice coaching conversation. She liked being able to see a model. She said she hopes the professional development for the university supervisors continues.

Linda provided many supports to the teacher candidates. She meets with them and provides them with resources. Her post conferences have improved with the incorporation of questioning and paraphrasing she learned from the coaching training. Linda said, “The conferences have more meaning, because the students are coming up with the plan and ideas.” She has been proud of the teacher candidates’ ability to reflect and problem solve.

Linda had high expectations for the candidates’ mathematics teaching. Her expectations included hands-on and active learning. She said that she prefers them to use manipulatives and a variety of strategies.

She provided support between the university and the field placement school. She is the most senior university supervisor and has built a great relationship with her

placement school. She provided resources to them and they welcome the new ideas and energy of the teacher candidates. She views the relationship as a “partnership”.

Linda taught elementary school mathematics closely aligned with the expectations that she has for the teacher candidates. She was consistently involved in professional development. She taught using an engagement with manipulatives, problem solving, and strategies. She enjoyed teaching mathematics.

Teacher Candidate Interviews

Ten teacher candidates agreed to an end of the semester in-depth interview. The interviews were transcribed, and then the researcher and another mathematics educator read and identified themes related to changes in beliefs and instruction, influential people, and the impact of the RTOP. The interviews were then re-read, and themes were then highlighted. Last, the themes were broken down into subcategories using the list of starter codes (Appendix O) as identified through the research and then additional themes that were identified in the coding. The researcher then summarized each interview individually and then summarized them as a collective group.

The ten candidates included seven undergraduate and three graduate teacher candidates. Candidates represented members from all four elementary mathematics methods sections. The three themes were: efficacy, RTOP use in improving their instruction, and influence of the university supervisor on their instructional practice.

The teacher candidates had a variety of experiences with mathematics in their K-12 education. Two teacher candidates said they have always been strong mathematics students, three were average, and five struggled with mathematics. Three of the five that struggled used some descriptive words to talk about their struggle, such as: anxious,

confidence, and challenged. One said that mathematics made her “anxious,” one said she had “low confidence”, and a third said she was “mathematically challenged.” Those that were average and strong mathematics students all referred to being strong with the use of traditional algorithms or having procedural knowledge. All ten teacher candidates referred to their elementary mathematics methods course experience as a positive one. They talked positively about the hands-on instruction. “Highlights were finding activities and ways to teach math in a real world, non-worksheet driven way,” one teacher candidate shared. Another teacher candidate shared this, “I struggled with learning how to do the problems and teach math without teaching the straight algorithm. I really had to work on that, and once I got the hang of it I really enjoyed it. I think that it’s a much better method for children to learn.”

The teacher candidates were asked to explain how their beliefs and attitudes about teaching and learning mathematics changed during the semester. One teacher candidate said she “got more hopeful.” She felt at the end of the semester she could see herself teaching the strategies that she learned in the elementary mathematics methods course. Three teacher candidates said that they were more confident in teaching mathematics. One said that her beliefs about mathematics instruction changed. She had always been successful with traditional methods, but now she realizes with instructional “change that mathematics can be fun for others.” One teacher candidate said that she became more positive. Another said she began the semester being “very nervous and skeptical.” She said her instructor was very positive, so that attitude rubbed off on others. She said she now feels more capable but still cautious. One candidate said that her beliefs and attitudes

did not change over the course of the semester. She adds that the course just solidified her previous vision of how to teach mathematics.

Another teacher candidate stated:

Definitely, I went into it (math methods) thinking I don't want to teach math. I'm scared of math. I'm going to mess these kids up. That's true (laughter). I really enjoyed teaching math, and it was actually one of my favorite things to teach. I haven't taught like social studies or science, but compared with like reading, math is like my favorite. And so I was really surprised by that.

To assess the candidates' stage according to Fuller's (1969) concern theory, teacher candidates' were asked about changes in their concerns over the semester. Seven of the teacher candidates could describe a change. They talked about their concern in the beginning in their field placements about being liked, fitting in, and even about their being nervous in the classroom. One candidate said she began the semester worried about merely clocking hours and getting everything accomplished; then she started working with a group of struggling students. She said her thoughts shifted to "their achievement and understanding" and less on her own "to do list." Some candidates said they felt a change, but their response was still focused on "the self." One answered that she didn't feel a change until "the students told her goodbye on the last day." Others talked about their change in terms of confidence. One of them said she is "finally not nervous about messing up the students' learning". One teacher candidate explained it in this way:

It's been amazing, I mean, because this was something I've always wanted to do. I've always wanted to teach, but once I actually got into it... there's such a big difference between planning and then actually being inside the classroom and

actually teaching the math lesson. It was very beneficial and it's really made me more confident about being not only a teacher but a good mathematics teacher.

Their opinion about the use of the RTOP to improve their teaching varied among the ten teacher candidates. Two of the candidates said that they didn't see the RTOP until the post-conference with their university supervisor, and one candidate said she did not know what the RTOP was. Nine of the teacher candidates used the RTOP to write their lesson plan reflections. One teacher candidate stated:

And as far as reflecting, it was good for me just to be able to get the feedback from my university supervisor. She was the one who filled that RTOP. It (the RTOP) hit so many different levels that a lot of the other observation forms don't hit. It covers so many different points of my teaching, not just content specific but, you know, the whole class room environment as a whole. And that was really helpful to just get feedback on so many different points.

Another candidate said that she analyzed the areas that she scored low on to inform her planning of her next lesson. Six candidates said that they used the RTOP to plan their lessons. One of the six teacher candidates who had to reteach her lesson said she didn't use it at all on her first lesson, but when planning the second one she went through it carefully to ensure she was on "target." Two said that they went and checked off each indicator. One of those teacher candidates said:

I used it for both (lessons). I use it, as kind of my rubric to make my lesson plans, so I try to make sure that I cover almost everything on that document. And then I also use it to reflect to make sure that it (the lesson) was okay. It was kind of like my checklist before I did the lesson and after I did the lesson; because even

though I planned to do something then when the lesson came, I might have forgotten because I was nervous or something like that. So it was good reflector and kind of like my pre-assessment kit.

One teacher candidate said that her university supervisor gave them the RTOP at the beginning of the semester and explained that this was how they would be assessed.

The influence of the university supervisor varied among the ten teacher candidates. When asked who provided the most support in planning their mathematics lessons, the university supervisor was not an answer from any of the teacher candidates. Three teacher candidates answered their elementary mathematics methods instructor, three answered their cooperating teacher, two gave credit to both their cooperating teacher and their mathematics methods instructor, and one teacher candidate said herself. The remaining teacher candidate said, “My cooperating teacher and me” were the most influential in planning. On another question, one teacher candidate did say that her university supervisor required them to turn in their lessons early in order to provide feedback prior to teaching.

Because all university supervisors were required to observe the mathematics teaching of the teacher candidates, teacher candidates were asked about the feedback that they received from the university supervisors. One teacher candidate summed up the support from the university supervisor:

She was pretty supportive throughout my lessons. She would come in to observe and then she would talk to me after the lesson was over usually like an hour later. So it was pretty fresh...Her talking to me was really helpful and going over the

RTOP was very helpful too 'cause she could show me her view of what she thought I should improve on.

Three teacher candidates found the feedback from the university supervisors to be positive. Another added that the feedback was beneficial and focused on the lesson planning. Two said that the university supervisor wanted to see more technology in their lessons. Another teacher candidate said the feedback was overwhelming, because “the university supervisor expects me to meet all the standards but the teachers in my school (field placement) weren’t meeting the standards.” One candidate said the feedback was constructive and honest. One teacher candidate did not comment on the feedback from her university supervisor.

Teacher candidates were also asked to describe the support that they received from their university supervisors during the fall 2011 semester. Two teacher candidates discussed the benefits of weekly meetings with their university supervisors. Three teacher candidates said the support was about instructional strategies and planning. Three loved the resources that the university supervisors provided. Two mentioned the importance of the supervisors’ timely feedback and follow-up. Two teacher candidates said that the university supervisors were “supportive”, and one called her “approachable.” Two teacher candidates said that their university supervisor was “not around” or was “late to appointments”, and only one teacher candidate said that the university supervisor did not provide any support. One candidate talked about accessibility of her university supervisor:

I remember a couple of times where it was 8:00, 9:00 at night and I would just text her...and she would just get right back to me. So she was very supportive, I

actually called her a couple of times so I always feel like even though she wasn't maybe there as much as she wanted to be I could always get a hold of her so she was always supportive for anything I needed, any questions.

Teacher candidates were asked how the university supervisor helped them improve or understand their teaching of mathematics. Three teacher candidates stated that the university supervisor did not have an impact on their mathematics teaching; one however stated that it was not about mathematics content or pedagogy but instead it was about general classroom management techniques. Five said that the university supervisors helped them with instructional planning; these strategies included objectives, questioning strategies, and the use of technology. One teacher candidate said that her university supervisor helped her focus on student thinking. One teacher candidate talked about how her supervisor helped her with mathematical understanding.

When it came to understanding (mathematics), I think she (the university supervisor) kind of broke it down and kind of let me know, okay this is what you need to teach the children and this is what they're doing in the schools. I had to kind of apply that when I was planning and teaching.

Teacher candidates did notice a disconnect between the instructional practice professed in their mathematics methods class and the mathematical teaching in their field placements. Three teacher candidates referred to the content of the methods course not matching what their cooperating teachers were doing at the time. This is an interesting statement, since the methods instructors do not require certain topics for the assignments related to teaching in the field placement; the assignments were specifically designed to be flexible around the state and local curriculum as well as be responsive to the needs of

the classroom teacher. Another disconnect noticed was between the university supervisors and the mathematics methods class. One teacher candidate referred to an instance where the mathematics methods instructor had her reteach her lesson and the university supervisor did not feel that it was necessary. The candidate shared, “she never did come and check to see how the second lesson went.” The teacher candidate added “nothing was ever said about it.” Another teacher candidate had a similar experience of being required to reteach according to the mathematics methods instructor, and the university supervisor did not see the same issues within the lesson.

Research Questions

Research Question One

What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?

The university supervisors experienced some changes in their beliefs and practices due to the professional development. According to the pre-post assessment data of the Mathematics Beliefs Instrument, beliefs about curriculum and learning changed toward a more constructivist view, but they did not make a significant change. Overall the practice of the supervisors changed. According to the interviews and observations with the university supervisors the way that they led their post-conferences changed with the addition of paraphrasing and using mediating questions. The university supervisors' expectations for teacher candidates' mathematics lessons changed as a result of the RTOP training.

The university supervisors consistently used the RTOP as a reference for high quality mathematics instruction. They repeatedly stated that they expected more rigor and higher level thinking as a result of the focus on the RTOP rather than the open-ended general observation form used in the past. This intensified level of expectations in the mathematics instruction included the requirement of K-5 students justifying and sharing their strategies. Interviews displayed an increase in the expectancy of real world and hands-on learning. They wanted to see the teacher candidates actively involving students. Even though two university supervisors did not assess the teacher candidates themselves, but instead used the teacher candidates' self-assessment on the RTOP, the use of the RTOP did increase the emphasis on the mathematics content knowledge and the pedagogical content knowledge.

The way that the university supervisors approached the post-conference changed for most of the university supervisors. They described that they listened more and put the emphasis on teacher candidates' reflections. They allowed the teacher candidates to problem solve and come up with their own strategies and ideas for improving their instructional practice.

Subtle changes in the beliefs of the university supervisors were noticed in the comparison of the pre- and post-assessment of the Mathematics Beliefs Instrument. Seven university supervisors changed their beliefs about there being only one way "right way" to solve a problem. Six university supervisors went from agreeing to the statement that mathematics can be right or wrong to only four believing that at the end of the semester. Two university supervisors changed their belief about having K-5 students justify their thinking in a single way to a more constructivist view of having students

justify in a variety of ways. One supervisor changed her thinking about problem solving being a distinct part of the curriculum to a more integrated view of problem solving

Research Question Two

What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?

Evidence obtained to determine the effects of training university supervisors on the teacher candidates' beliefs and instruction were gathered from interviews with ten teacher candidates and the pre- and post-test data from the Mathematics Beliefs Instrument. There were changes in beliefs identified according to the analysis of the results from the Mathematics Beliefs Instrument.

There were also changes identified from the spring semester to the fall semester. The Mathematics Beliefs Instrument results from the teacher candidates that participated in the baseline study and the teacher candidates in this study revealed some changes in beliefs. Teacher candidates in the baseline study held more traditional beliefs at the end of their methods course compared to the teacher candidates in the present study. 33% of the baseline teacher candidates felt that problem solving should be a distinct and separate part of the curriculum compared to 15% of the teacher candidates at the end of the current study. Another difference in beliefs was that 27% of teacher candidates in the baseline study believed students should justify their solutions, thinking, and conjectures in a single way; this is compared to only five percent of the teacher candidates at the end of this study. Another difference was in the belief that computation should precede word problems; 16% disagreed in the spring while 64% disagreed at the end of this study. In the spring, 27% of teacher candidates believed the mathematical strands should be taught

in isolation compared to 8% in the fall. The beliefs about kindergarteners' knowledge also showed a difference. Beliefs also changed in regard to efficacy, 5% in the spring believed that they wouldn't be good at teaching mathematics compared to 4% in the fall. In the spring 72% of teacher candidates believed they were good at learning mathematics compared to 81% in the fall displaying an increase in the confidence level of teacher candidates.

There were also changes in beliefs from the pre-and post-assessment data as demonstrated through the results of the Mathematics Beliefs Instrument. These results were presented in a previous section, but will be summarized again here. More teacher candidates believe children should justify their solutions, thinking, and conjectures in a multiple ways. Teacher candidates ended the semester believing the mathematical strands such as geometry and algebra should not be taught in isolation. More teacher candidates believed that there should be an increased emphasis on clue/key words at the beginning of the semester compared to the end of the semester. Fewer teacher candidates believed that learning mathematics is a process of absorbing information. More teachers believed good reasoning should be regarded even more than students' ability to find correct answers. At the end of the semester more teacher candidates displayed higher efficacy in terms of their ability to learn mathematics and their ability to be an effective teacher of mathematics.

In order to triangulate the results of the Mathematics Beliefs Instrument for the university supervisors, interviews, and observations were conducted. This was done to obtain information about the cause of the changes identified in the Mathematics Beliefs Instrument. Interviews conducted during the fall of the 2011 semester revealed that the

university supervisors did have some influence on the teacher candidates' beliefs and instruction.

Interviews were also conducted for the previous semester as an additional comparison. Teacher candidates in both semesters spoke positively about their elementary mathematics methods experience. In the spring, the three teacher candidates in the baseline study credited this positive learning experience to their mathematics methods instructor. In the fall there was a mix of responses that included both the contributions of the mathematics methods instructor and the cooperating teacher. In the spring, the teacher candidates had positive support from their university supervisor, however, each detailed that the support was in areas of classroom management and implementation strategies with none mentioning mathematical support. With the program change of requiring university supervisors to observe the mathematics lessons and use the RTOP, an increase in dialogue about feedback on mathematics teaching was noted. Four university supervisors read and covered each indicator on the RTOP. Two had the teacher candidates reflect on each indicator. Other university supervisors assessed the teacher candidates using the RTOP and provided them with a copy. Three of the teacher candidates found this feedback to be helpful. One university supervisor read lesson plans prior to the teaching in order to give feedback. While the candidates did not speak specifically about mathematics they were aware of the focus of the study, five candidates talked about instructional support that included objectives, strategies, and technology. Three teacher candidates stated the university supervisor did not have an impact on their instructional decisions.

Lastly, university supervisors were interviewed to assess whether there was a change in the instructional practice of the teacher candidates in the teaching of mathematics. All but one university supervisor noticed a change in teacher candidates' mathematics planning and teaching. The university supervisors noticed a greater focus on teacher candidates preparing lessons that encouraged K-5 students' exploration and use of different methods to investigate problems. They saw an increase in a variety of instructional strategies and assessment. One university supervisor shared that it was easier for the teacher candidates to execute the lesson; it was the easiest content area for them to plan and teach. Another university supervisor said that the teacher candidates were well trained in their mathematics. They noted that there was a definite emphasis on conceptual understanding and the teacher candidates focused on this in their planning. One university supervisor had this to say:

There was a lot more post-discussion about concrete materials used in teaching and then movement to the abstract. The teacher candidates were noticed as really focusing more consistently and intentionally on open discussion about how each child solved the problems. The supervisors noticed that they also seemed to be trying harder to meet the needs of all learners.

Program Evaluation

The data collected provided insight into the recent program change. This study was a program evaluation of the effects of providing professional development for the university supervisors on their supervision practice. According to the interviews, all university supervisors spoke highly of the professional development and would like to see the coaching continued and cover different content areas. They liked having the forum to be able to problem solve and have a shared common ground about how to

support and conference with teacher candidates, especially when it came to problems with teacher candidates. The university supervisors saw the professional development and follow-up as a positive system of support for their work for the university.

In implementing the program change, professional development was required in addition to the university supervisors using the RTOP to observe all mathematics lessons. In analyzing the data, two university supervisors did not actually assess the teacher candidates. Instead, they had the teacher candidates self-assess during the post-conference. This is problematic and is different from what the university expects from the supervisors. It was unclear as to whether this is an artifact of this particular observation tool or whether this was a common practice of the supervisor.

Accountability to adhere to program expectations was also a problem that became apparent during the study. The university supervisors were expected by the university to attend professional development; however, two university supervisors had to be pursued in order to get them to comply. The follow-up meeting in the fall also did not have full attendance. This caused a problem with consistency in implementation and program expectations. Two university supervisors also did not schedule observations as outlined. Six university supervisors had the cooperating teacher do one observation which was not aligned with the stated expectations.

Summary

This study used both qualitative and quantitative data to analyze a program change requiring university supervisors to attend professional development. Measures included pre- and post-survey data from the Mathematics Belief Instrument (MBI), scores from the RTOP, observations from university supervisor led post-instruction conferences, and interviews of both university supervisors and teacher candidates.

CHAPTER V

DISCUSSION

This chapter discusses the results presented in Chapter IV. Sections for this chapter include a summary of the study, connections of the findings to the literature, and conclusions. The conclusions for this study address the implications, limitations and recommendations for future research.

Summary of the Study

Restatement of the Problem

The teaching of elementary mathematics has remained stagnant despite reform efforts and the implementation of more rigorous standards (Beswick, 2006). Teachers choose their instructional strategies based on their belief system (Karp 1988, 1991; Kolstad & Hughes, 1994; Pajaras, 1992, Wilkins, 2002). If these belief systems are not identified and challenged, the beliefs provide a barrier for change and limit the use of instructional strategies (Wilkins, 2002). This places the burden of identifying these restrictive beliefs and creating an atmosphere of change on teacher education programs. A critical influence on teacher candidates is the university supervisor assigned to their field placement site. The supervisors provide the connection between theory and practice during the critical time prior to student teaching (Grossman et al., 2008). As accountability increases for teacher preparation institutions to prove effectiveness of their teacher candidates, all aspects of the program have to be evaluated and supported. University supervisors must be provided with the necessary professional development in

order to prevent the disconnect between the philosophy of the teacher education program and the reality of the field placement that is possible with that role. They provide the bridge between the ideologies of the university and the characteristics of the field placement.

Restatement of Purpose and Research Questions

The purpose of the current study was to investigate the impact on university supervisors' supporting role after they receive professional development in the areas of coaching and reform-based mathematics pedagogy. The present study was a program evaluation study designed to examine the relationship between elementary university supervisors' support and teacher candidates' beliefs and abilities about mathematics teaching and learning.

Two questions guided the focus of this study:

1. What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?
2. What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?

Review of Methodology

A mixed methods design incorporating both quantitative and qualitative analyses was used to answer the above questions (Tashakkori & Teddlie, 1998). The use of both quantitative and qualitative data is important to fully capture the dynamic of this programmatic change and provide triangulation to increase the validity of the results.

Quantitative data were gathered in scores from the Reform Observation Teacher Protocol (RTOP), the Mathematics Beliefs Instrument, and background information. The Mathematics Beliefs Instrument was used as a pre-and post-assessment to assess a change in beliefs from the beginning of the study to the end. The data from the quantitative data was enhanced by the collection of qualitative data in the form of observations and interviews.

Summary of Findings

Research Question One. What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?

The university supervisors benefited from the professional development. All found value in the training and would like to see it continue. With the implementation of any new change, problems are to be anticipated. University supervisors are still more concerned with elements of lesson planning and classroom management versus the quality of the mathematical learning experience. The observations revealed that some of the university supervisors did not talk about the mathematics content or pedagogy of the lesson, while others made it a part of the conversation. This was a noticeable difference from the data collected in the baseline study. University supervisors still scored lessons high if manipulatives were used and students were compliant, but methods were “traditional.” When asked after a post-conference, why she did not address the mathematics, one university supervisor said that she did not want to upset the teacher candidate. The same supervisor on another instance said that developmentally the teacher candidates could not handle criticisms. Two of the university supervisors commented in

interviews that elements of the RTOP were not always appropriate. One even stated that a teacher could not be expected to use student- centered instruction daily.

Comparing the interviews from the baseline data to the interviews from the current study, teacher candidates did experience an increase in mathematics support from the university supervisors, even though they were not the most influential person on their mathematics teaching. Evidence from the teacher candidate interviews revealed the importance of the mathematics methods instructor and the cooperating teacher. These influences were not the focus of the study, but it is evident that they are critical in the development and support of teacher candidates.

Research Question Two. What are the effects of training university supervisors in mathematics education coaching practices on teacher candidates' beliefs and instruction in mathematics?

The findings also reveal some subtle changes in beliefs on the part of the university supervisors and the teacher candidates. Six university supervisors did not have teacher candidates whom experienced a significant change in beliefs according to the results of the paired t-test on the MBI scores. Three of these university supervisors exhibited negative behaviors or actions during the study. Prior to the professional development one of the supervisors e-mailed the director saying that “she would have to be paid in order to attend.” Another had to have an administrator contact her in order to get her to attend the professional development and participate in the observations and interview. Both of these university supervisors also did not set personal goals for the semester. A third university supervisor did not participate in the observations and outwardly admitted that she dislikes mathematics. These negative factors could have

attributed to the non-significant results of their teacher candidates. Another of those five supervisors was new to the position with the university, so her getting acclimated to the role could have impacted her influence on the teacher candidates. The fifth supervisor had three years of experience. Looking at her two post-observation conferences one did not have any questions related to the mathematics in the lesson and the second had only two questions out of twelve related to mathematics. So the inconsistent focus on mathematics could be the attributing factor to her insignificant results.

When grouping the teacher candidates by their instructor, two instructors had significant change in all three belief constructs. A third instructor had a significant change in two of the constructs, and the fourth instructor did not have any significant change in the beliefs of her teacher candidates. This instructor was a part-time adjunct instructor. This was her first time teaching the course. She also had seven of her sixteen teacher candidates who were not observed by a university supervisor. This means that the university supervisors did not have a post-conference with these teacher candidates. These teacher candidates did not have the same opportunity to be coached and reflect on their teaching of mathematics as other teacher candidates in the program.

The interviews from the university supervisors also revealed a change in the teacher candidates' instructional practice. The university supervisors noticed a greater focus on student centered instruction that incorporated questioning strategies, student thinking, manipulatives, and strategies.

Observations revealed that in 15 out of 19 post conferences paraphrasing was used. Closed and probing questions were the most common types of questions asked verses the more reflective mediating and open-ended questions. The coaching practices of

the university supervisors are in the novice stages. In reviewing the post-conferences, the limited use of paraphrasing with the teacher candidates displays a need for more professional development, modeling and practice. In order to facilitate change in beliefs and practices, university supervisors need to practice active listening which is demonstrated through the use of paraphrasing. Some of the university supervisors need to examine the type of questions that are asked. Closed questions should be used sparingly as they often require a single answer and don't foster reflection but evaluation. Questions should also be connected and based on the teacher candidates' response to the paraphrase or previous question.

Program Evaluation

Ultimately, this study was an evaluation of the elementary program change of requiring the elementary university supervisors to attend professional development and implement change in their practice. This program change was made in April 2011. University supervisors were notified prior to renewing their contracts for the upcoming year and all signed that they were agreeable to this change.

One problem was evident, the requirement of attendance which reflected on the level of commitment by the university supervisors. Despite the change to their job requirements, attendance to follow-up sessions was not 100%. Attendance was expected, versus required. On the October 14th follow up session, seven elementary university supervisors (63.64%) were in attendance. 100% participated in the professional development, but not as initially designed. The researcher had to pursue two university supervisors in order to get their cooperation to complete the training. Conducting a professional development session for an individual or with two individuals is different

from the interactions and energy generated with a group. The dynamics change and the implementation of group activities was hindered by this unusual implementation. So for these two university supervisors the professional development was different.

Another issue with the program change evaluation is that the elementary university supervisors are not held accountable to follow program expectations. The expectation is for the university supervisors to observe all elementary mathematics methods students teach their math lesson. However, five elementary university supervisors failed to observe one of their candidates and one elementary university supervisor failed to observe two of her teacher candidates. These university supervisors allowed the cooperating teacher to assess the teacher candidates with the RTOP. The cooperating teachers are not trained on the RTOP tool and were not eligible to carry out the evaluation with effectiveness and fidelity to the components of the instrument.

These two issues highlight the need to hold elementary university supervisors accountable for program policies and expectations. One possible solution for these issues of attendance, completing forms, and other requirements of the program could be connecting these issues to their annual evaluation and use this data to help determine if they are rehired in the base of those who are not full-time faculty.

Because some university supervisors in this study didn't address the mathematics content or pedagogy of the lessons observed by the teacher candidates, the selection criterion for university supervisors may need to be reconsidered. This issue also speaks to the need for an increase in professional development and support. University supervisors are either not addressing the mathematics content or pedagogy because they are

uncomfortable or because they do not know to address it. As the program moves forward this is an issue to consider and make adjustments.

Also the use of the RTOP as an observation tool was implemented with inconsistencies. Two university supervisors had the teacher candidates self-assess instead of evaluating the candidates as per the training. This inflated the RTOP scores for some candidates. If the teacher candidates could justify one of the descriptors, the supervisors circled primarily threes and fours out of the four point scale. Other supervisors also had inflated scores. Due to the limited professional development on the use of the RTOP and coaching strategies, university supervisors did not get necessary time to build confidence with the instrument and expectations. Further training and support in the use of the RTOP is needed in order to increase the fidelity to implementation and increase the integrity of the tool as an appropriate assessment and stimulus for change.

Another issue that became apparent during the interviews with the university supervisors is their knowledge and understanding of the mathematics methods assignments. Four of them mentioned a need for the mathematics methods instructors to align their assignments to the curriculum of the field placement schools and districts. This was an interesting request, because the assignments are designed to fit any mathematical strand to accommodate the differences in curriculum maps. If this is a common belief, this means there is a disconnect in the communication of the assignment goals

Last, many of the university supervisors did not feel that they were responsible for bridging the expectations of the university and the field placement school. Three of them felt that the methods instructors should provide this service. They were more inclined to

have the teacher candidates teach like the cooperating teacher instead of meeting the expectations of the mathematics methods course and nationally recognized standards.

In summary, as the elementary teacher education program moves forward some additional procedures and policies need to be considered. Recommendations for the program include articulating clear expectations and evaluation for faculty and part-time staff who serve in the role of university supervisor. University supervisor attendance at professional development sessions is critical in order to provide consistency and fidelity in program implementation that guides and supports the clinical experiences of teacher candidates. As university supervisors agree to this assignment, this expectation should be clear and fulfilled.

For full time faculty who are assigned university supervision as part of their annual workload agreement and who receive a course equivalency for supervising a group of teacher candidates, attendance and participation should be expected and evidence provided, in order to determine whether that faculty member has met the program requirements for all supervisors, faculty or part-time personnel.

Following through on all levels with program expectations is necessary for fidelity of implementation and for the success and support of teacher candidates. Because of this need and the key role the clinical experiences triad holds in new teacher preparation and development, evaluation of all faculty and part-time staff should include levels and quality of participation, compliance related to program elements, and evaluation of the types of coaching and support university supervisors provide. Last, a consistent model of criteria for university supervisor selection and evaluation needs to be considered and infused in order to ensure quality support for teacher education

candidates' mathematics education teaching. Criteria need to be developed in order to select high quality university supervisors in order to enhance the consistency and quality of support. Evaluation and feedback cycles should include systematic opportunities for responses from teacher candidates, personnel at the placement school, and at the university level from a department chair (or program coordinator) who oversees the clinical supervision and who contributes evidence to the faculty member's annual review. Such a model is aligned with the systematic practices of high performing K-12 schools in their expectations and evaluation of faculty and staff and is supported by the research literature, reviewed extensively in this study, on the need for high quality clinical supervision and support of teacher candidates in teacher education programs.

Connecting Findings to Literature

The current expectation for teacher preparation programs is to be held accountable for the quality of their graduates (Data Quality Campaign, 2010). Elementary student test scores in mathematics will be linked directly to their teachers and then to the teachers' preparation program (Data Quality Campaign, 2010). This places additional pressure on colleges of education. The integrity of a program is based on the consistency and implementation of the expectations. This means that teacher preparation programs are responsible for all faculty providing support and education for the teacher candidates. The performance of all faculty is important especially the university supervisors who are expected to bridge both worlds – the theoretical course work and the practice in the field placement. Assessment of a program's effectiveness has to include an evaluation of faculty performance (NCATE, 2008). Standard five (NCATE, 2008) lays the foundation for assessing faculty performance and providing the professional development necessary

to improve faculty practices, and standard three evaluates field experiences and clinical practices. This study evaluated one elementary teacher program after the addition of professional development for university supervisors.

There were some university supervisors who did not implement and adhere to the new program guidelines and expectations. Inconsistencies in implementation send mixed messages within the program and hinder the effectiveness of the field placement (McIntyre, Byrd, & Fox, 1996). If a program is to be effective, the expectations and philosophies of the program have to be congruent (McIntyre, Byrd & Fox, 1996), and the supervision of candidates has to be a priority (Albasheer et al., 2008). This study also found that it is necessary to have cohesiveness in philosophy and expectations. University supervisors provide influential support in the education and development of teacher candidates (Blanton, Berenson & Norwood, 2001; Freidus, 2002; Frykhol, 1998; Laboskey & Richert, 2002; Smith & Souviney, 1997).

Beliefs are difficult to change (Nosich, 2009; Pajaras, 1992). They must be identified and explicitly addressed in order to be changed (Nosich, 2009; Stuart & Thurlow, 2000). The beliefs of teacher candidates provide a filter for learning (Nosich, 2009). As teacher candidates enter the teacher preparation program they come with strongly held beliefs about teaching and learning. Those providing instruction and support have to recognize and address these beliefs if mathematics instruction is going to change. It is evident from this study that some beliefs were changed due to the program change of providing professional development to the university supervisors and introducing the RTOP as an observation tool. The professional development consisted of a day and a half plus one follow-up session. The literature on professional development

identifies duration as an important element that fosters instructional change (Shields, Marsh, & Adelman, 1998; Weiss, Montgomery, Ridgway, & Bond, 1998). This study demonstrated that change can happen the first year, but the support and professional development for the mathematics instructional strategies and more importantly for coaching practices will have to continue if the change is expected to be long lasting (Ganser, 1997; Obara, 2010; Saphier & West, 2010; Young et al., 2005). This study offers the focus on providing university supervisors with training in the area of coaching. This is a new addition into the area of university supervisor support. Coaching increases the likelihood of instructional change.

Connections to Theoretical Framework

Fuller's Concern Theory (1969) was chosen to provide the framework for identifying teacher candidates' change in focus during the course of the current study. Both the university supervisors and the teacher candidates could relate to the three phases of Fuller's Concern Theory: *self, task, and impact*. During the culminating interviews, seven out of the ten teacher candidates interviewed could articulate their movement from focusing on the tasks of the semester, and ending with more concerned with their impact on students. Three of the candidates could not identify with the impact stage. University supervisors also could articulate their movement from task to impact based on the professional development. They slowed down in their conferences with teacher candidates and focused more on getting the teacher candidate to reflect, instead of the previous focus of completing a set of observations or completing paperwork.

Social constructivism (Cobb, et al., 1992; Meehan, et al., 2001) was also observed during the study. Teacher candidate learning was not achieved in isolation (Cobb, et al.,

1992; Meehan, et al., 2001), but is influenced by many variables. For the current study, the influence of the instructors was apparent in the interviews with the teacher candidates. All candidates talked positively about their elementary mathematics methods instructors. Most teacher candidates had a positive learning experience with their cooperating teachers. The influence of the release and implementation of the Common Core Standards (CCSSO, 2010) was evident for the teacher candidates. Their cooperating teachers were making adjustments to the curriculum and trying to fill in gaps between the previous state standards and the new Common Core Standards. The purpose of this study was to examine the impact of the support provided by the university supervisors. This study displayed that the university supervisor feedback and support did make a difference.

Conclusions

Implications

Teacher preparation programs can increase their effectiveness by providing professional development to their university supervisors. Mathematics education is the foundation for the instructional strategies that teachers use to increase the understanding of mathematics by K-5 learners. However, all stakeholders must be on the same page when it comes to the expectations for mathematics instruction. With the release of the Common Core State Standards for mathematics, the expectations for students changed in often dramatic ways. Teachers have to be prepared to teach for understanding and not just procedural knowledge. The examples in the field and the expectations of the cooperating teacher and university supervisor have to match the mathematics methods instructor and

these important standards and research based practice. Congruence is important as to not cause a disconnect and instead give mixed messages to the teacher candidates.

The implications are clear. University supervisors need professional development and support. Coaching is an effective form of support that can provide a change in thought and practice. The elementary education program should continue these efforts. The university supervisors found the support to be helpful in their practice. This type of support is necessary as the accountability of teachers and the performance of their elementary student is placed squarely on teacher preparation programs. In addition to the continuation of the professional development, education programs need to continue their evaluation of all faculty that provide support to teacher candidates. This includes analyzing the best practice for selecting university supervisors. This analysis should include considering whether full time professors and instructors should take on the role of university supervisor. Mathematics educators should also continue to identify the beliefs of teacher candidates and also assist in fostering reflection.

Limitations of the Study

This study had several limitations. One university supervisor did not schedule the required co-observations with the research. She did not respond to multiple e-mails and notifications. Because of this, the study is missing the some of the comparison data for this university supervisor. In the interview, she shared that mathematics was always difficult for her, and this fact this could have led to her to avoid the joint observations with the researcher.

Another university supervisor was very resistant to scheduling the professional development sessions and the observations. She finally complied with the requirement of

being observed after the intervention of an administrator, but exhibited unprofessional behavior throughout. For the one scheduled observation, the university supervisor was very distracted; she checked her watch numerous times in addition to checking her cell phone while the teacher candidate was teaching. She huffed and made noises during the teacher candidates' teaching. The post-conference that she led was only ten minutes long. She ended the conference by looking at the researcher and asking if I would like her to do or ask anything else.

Another problem that became apparent at the end of the semester was with one mathematics methods instructor. She was part-time and allowed seven of her students to be observed by their cooperating teacher instead of their university supervisor. This was a miscommunication on part with the methods instructor and the university supervisors. All were informed that the university supervisor was required to observe all mathematics lessons. This exhibits another problem of compliance to program expectations.

The professional development was the first time that attendance was required for the university supervisors at such a session. Two supervisors had to have individual sessions outside the two options of scheduled dates. This caused problems in the consistency and cohesiveness of the new expectations and guidelines. Also the follow-up meeting was not mandatory. There was only partial participation of university supervisors. So not all of them got to have a refresher and revisit their goals. This is another problem with compliance of program expectations.

Another limitation is the researcher also being one of the mathematics methods instructors. No problems were explicitly revealed with this dynamic, the researcher took precautions to ensure protection of her assigned teacher candidates. The researcher did

not interview her own students or administer the MBI to her own students. Another instructor interviewed the teacher candidates from the researcher's class. Three students from the researcher's section of elementary mathematics methods were part of the university supervisors' observations. Although these candidates were not the focus of the observation – it was the evaluation of the candidate by the supervisor, this situation does need to be acknowledged. Richardson (1996) advocated for the researcher to be part of research on beliefs in teacher education programs. So while it is a limitation, it can also be seen as a benefit.

Recommendations for Future Research

Due to the overwhelming focus on lesson planning and behavior management during the post-lesson conversations of the university supervisors, a comparison of post-conferences of other content areas with mathematics post conferences would provide insights into whether university supervisors avoid content specific questions and topics about content that they are uncomfortable with or just avoid all mention of all content areas. By comparing post conversations, evidence would reveal more about the topics for reflection in the post conference. For example, do university supervisors always ignore the content – or is it limited to areas where their expertise is limited?

Another possibility is to study the impact of coaching strategies on teacher candidates' beliefs and instruction. This study would include increasing the number of professional development hours for university supervisors. The university supervisors in the current study only received a day and a half of training and by increasing the contact hours the benefits may multiply.

The current study examined the possibility for a change in mathematical beliefs over the course of one semester. Another recommendation for future research is a longitudinal case study of teacher candidates and changing beliefs over the course of their teacher education program. This study would start by gathering baseline data at the beginning of their required mathematics courses prior to taking their mathematics methods course and follow them until the end of student teaching.

Teacher candidates spend a lot of time with their cooperating teachers and their mathematics methods instructors. Another study would include the cooperating teacher and their mathematics methods instructor. Both of these individuals influence the instructional choices made by the teacher candidates.

The current study does begin to provide an argument for the need and support of elementary mathematics specialists in the elementary schools. Additional studies need to be done to address this need officially. In order to support high quality mathematics instruction, the instructional coach should have an expertise in mathematics.

Summary

Changing beliefs is a complex shift in ideas that require an intentional experience, education, and reflection. The members of the teaching triad must be cognizant in understanding the power of beliefs, reflection, and experience, in addition to strong mathematics pedagogy and content knowledge. Those coaching the teacher candidates need support and professional development in order to increase their effectiveness. Without an expertise in mathematics content, the coaching conversations lack in the power to spark instructional change.

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Subject Informed Consent Document

Stefanie Livers **852.0574**
Department of Teaching and Learning
University of Louisville
Louisville, KY 40292

You are invited to participate in a research study. The study is being conducted by Stefanie Livers under the supervision of Dr. Karen Karp.

The purpose of this study is to investigate the relationship between university supervisors and teacher candidates' beliefs about the teaching of mathematics.

First, you will be given a pre-assessment questionnaire (MBI) that contains some background information and gathers information about your beliefs of mathematics. The second task is to allow observations of your supervision of mathematics methods students or student teachers teaching mathematics; this includes the pre-conference meeting, observation, and post conference meeting. Due to scheduling, all of these might not be observed. The last requirement is an end of the semester interview and a retaking of the MBI.

Potential Risks

Benefits

The information collected may not benefit you directly. The information learned in this study may be helpful to others.

Confidentiality

Total privacy cannot be guaranteed. Your privacy will be protected to the extent permitted by law. If the results from this study are published, your name will not be made public. While unlikely, the following may look at the study records:

The University of Louisville Institutional Review Board, Human Subjects Protection Program

Voluntary Participation

Taking part in this study is voluntary. You may choose not to take part at all. If you decide to be in this study you may stop taking part at any time. If you decide not to be in this study or if you stop taking part at any time, you will not lose any benefits for which you may qualify.

Research Subject's Rights, Questions, Concerns, and Complaints

If you have any concerns or complaints about the study or the study staff, you have three options.

You may contact the principal investigator at 852-0561.

If you have any questions about your rights as a study subject, questions, concerns or complaints, you may call the Human Subjects Protection Program Office (HSPPO) (502) 852-5188. You may discuss any questions about your rights as a subject, in secret, with a member of the Institutional Review Board (IRB) or the HSPPO staff. The IRB is an independent committee composed of members of the University community, staff of the institutions, as well as lay members of the community not connected with these institutions. The IRB has reviewed this study.

If you want to speak to a person outside the University, you may call 1-877-852-1167. You will be given the chance to talk about any questions, concerns or complaints in secret. This is a 24 hour hot line answered by people who do not work at the University of Louisville.

This paper tells you what will happen during the study if you choose to take part. Your signature means that this study has been discussed with you, that your questions have been answered, and that you will take part in the study. This informed consent document is not a contract. You are not giving up any legal rights by signing this informed consent document. You will be given a signed copy of this paper to keep for your records.

Signature of Subject

Date Signed

Signature of Person Explaining the Consent Form
(if other than the Investigator)

Date Signed

Signature of Investigator

Date Signed

LIST OF INVESTIGATORS PHONE NUMBERS

E-MAIL

Stefanie Livers

852-0574

stefanie.livers@louisville.edu

Subject Informed Consent Document
IRB assigned number:

Introduction and Background Information

Purpose

Procedures

If you are uncomfortable being a part of the study, you may decline participation at any time without any negative effects on your grade and/ or your success in the course.

Potential Risks

There are no foreseeable risks, although there may be unforeseen risks.

Benefits

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Confidentiality

Total privacy cannot be guaranteed. Your privacy will be protected to the extent permitted by law. If the results from this study are published, your name will not be made public. While unlikely, the following may look at the study records:

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Taking part in this study is voluntary. You may choose not to take part at all. If you decide to be in this study you may stop taking part at any time. If you decide not to be in this study or if you stop taking part at any time, you will not lose any benefits for which you may qualify.

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APPENDIX C

MATHEMATICS BELIEFS INSTRUMENT

Mathematics Beliefs Instrument (MBI):

Part A

[Note: the response that more closely aligns with the NCTM Standards is in italics]

1. Problem solving should be a *SEPARATE, DISTINCT* part of the mathematics curriculum.

Agree

Disagree

2. Students should share their problem-solving thinking and approaches *WITH OTHER STUDENTS*.

Agree

Disagree

3. Mathematics can be thought of as a language that must be *MEANINGFUL* if students are to communicate and apply mathematics productively.

Agree

Disagree

4. A major goal of mathematics instruction is to help children develop the belief that *THEY HAVE THE POWER* to control their own success in mathematics.

Agree

Disagree

5. Children should be encouraged to justify their solutions, thinking, and conjectures in a *SINGLE* way.

Agree

Disagree

6. The study of mathematics should include opportunities of using mathematics in *OTHER CURRICULUM AREAS*.

Agree

Disagree

7. The mathematics curriculum consists of several discrete strands such as computation, geometry, and measurement which can best be taught in *ISOLATION*.

Agree

Disagree

8. In K-5 mathematics, *INCREASED* emphasis should be given to reading and writing numbers *SYMBOLICALLY*.

Agree

Disagree

9. In K-5 mathematics, INCREASED emphasis should be given to use of CLUE WORDS (key words) to determine which operation to use in problem solving.

Agree Disagree

10. In K-5 mathematics, skill in computation should PRECEDE word problems.

Agree Disagree

11. Learning mathematics is a process in which students ABSORB INFORMATION, storing it in easily retrievable fragments as a result of repeated practice and reinforcement.

Agree Disagree

12. Mathematics SHOULD be taught as a COLLECTION of concepts, skills and algorithms.

Agree Disagree

13. A demonstration of good reasoning should be regarded EVEN MORE THAN students' ability to find correct answers.

Agree Disagree

14. Appropriate calculators should be available to ALL STUDENTS at ALL TIMES.

Agree Disagree

15. Learning mathematics must be an ACTIVE PROCESS.

Agree Disagree

16. Children ENTER KINDERGARTEN with considerable mathematical experience, a partial understanding of many mathematical concepts, and some important mathematical skills.

Agree Disagree

Part B

[Note: the directional change that most closely aligns with the NCTM Standards is listed at the beginning of each item]

17. Some people are good at mathematics and some aren't.

true more true more false false
than false than true

18. In mathematics something is either right or it is wrong.

true more true more false false
than false than true

19. Good mathematics teachers show students lots of different ways to look at the same question.

true	more true	more false	false
	than false	than true	

20. Good math teachers show you the exact way to answer the math question you will be tested on.

true	more true	more false	false
	than false	than true	

21. Everything important about mathematics is already known by mathematicians.

true	more true	more false	false
	than false	than true	

22. In mathematics you can be creative and discover things by yourself.

true	more true	more false	false
	than false	than true	

23. Math problems can be done correctly in only one way.

true	more true	more false	false
	than false	than true	

24. To solve most math problems you have to be taught the correct procedure.

true	more true	more false	false
	than false	than true	

25. The best way to do well in math is to memorize all the formulas.

true	more true	more false	false
	than false	than true	

26. Males are better at math than females.

true	more true	more false	false
	than false	than true	

27. Some ethnic groups are better at math than others.

true	more true	more false	false
	than false	than true	

28. To be good in math you must be able to solve problems quickly.

true	more true	more false	false
	than false	than true	

Part C

[Note: The arrow at the beginning of each item indicates direction of enhanced efficacy.]

29. I am very good at learning mathematics.

true	more true	more false	false
	than false	than true	

30. I think I will be very good at teaching mathematics.

true	more true	more false	false
	than false	than true	

Appendix D
BACKGROUND INFORMATION FOR UNIVERSITY SUPERVISORS

Number of years teaching: _____ Number of years in education: _____

List your degrees and certifications:

Are you a National Board Certified Teacher? Yes or No

Number of years as university supervisor: _____

Assigned school(s): _____

Coaching/ Mentoring training: _____

Mathematics Experience

Number of years teaching mathematics: _____

Are you a member of the National Council of Teachers of Mathematics (NCTM) or one of the local affiliates? Yes or No

Mathematics training or professional development:

Date (year only)	Professional development/ training

What kind of mathematics student were you?

High (above 90%) _____ Above average (80%-90%) _____ Average (70%-80%) _____

Below average (50%-70%) _____ Low (below 50%) _____

How would you classify your supervision practice? Circle one.

Direct

Non-direct

Coach

Collaborator

Mentor

Delegate

Evaluator

Supervisor

APPENDIX E RTOP

RTOP: Reformed Teaching Observation Protocol

Teacher Candidate:	Observer:
Grade Level:	Date:

Lesson Plan & Implementation

	Never Occurred		Very Descriptive		
1.) Instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0	1	2	3	4
2.) The lesson was designed to engage students as members of a learning community.	0	1	2	3	4
3.) In this lesson, student exploration preceded formal presentation.	0	1	2	3	4
4.) This lesson encouraged students to seek and value alternative modes of investigation or of problem solving	0	1	2	3	4
5.) The focus and direction of the lesson was often determined by ideas originating with students.	0	1	2	3	4

Content

		Never Occurred		Very Descriptive		
Propositional Knowledge	6.) The lesson involved fundamental concepts of the subject.	0	1	2	3	4
	7.) The lesson promoted strongly coherent conceptual understanding.	0	1	2	3	4
	8.) The teacher had a solid grasp of the subject matter content inherent in the lesson.	0	1	2	3	4

Procedural Knowledge	9.) Elements of abstraction (ie., symbolic representations, theory building) were encouraged where it was important to do so.	0	1	2	3	4
	10.) Connections with other content disciplines and/ or real world phenomena were explored and valued.	0	1	2	3	4
	11.) Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	0	1	2	3	4
	12.) Students made predictions, estimations and/or hypotheses and devised means for testing them.	0	1	2	3	4
	13.) Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	0	1	2	3	4
	14.) Students were reflective about their learning.	0	1	2	3	4
	15.) Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	1	2	3	4

Classroom Culture

		Never Occurred			Very Descriptive	
Communicative Indicators	16.) Students were involved in the communication of their ideas to others using a variety of means and media.	0	1	2	3	4
	17.) The teacher's questions triggered divergent modes of thinking.	0	1	2	3	4
	18.) There was a high proportion of student talk and a significant amount of it occurred between and among students.	0	1	2	3	4
	19.) Student questions and comments often determined the focus and direction of classroom discourse.	0	1	2	3	4
	20.) There was a climate of respect for what others had to say.	0	1	2	3	4
Student	21.) Active participation of students was encouraged and valued.	0	1	2	3	4
	22.) Students were encouraged					

	to generate conjectures, alternative solution strategies, and ways of interpreting evidence.	0	1	2	3	4
	23.) In general the teacher was patient with students.	0	1	2	3	4
	24. The teacher acted as a resource person, working to support and enhance student investigations.	0	1	2	3	4
	25.) The metaphor "teacher as listener" was very characteristic of this classroom.	0	1	2	3	4

Feedback:

APPENDIX F

TEACHER CANDIDATE – BACKGROUND INFORMATION

Name: _____ Male or Female Age: _____

Course: EDTP _____ BA or MAT

Placement School: _____ University Supervisor: _____
GPA: _____ Grade 151 _____ 152 _____ ACT _____ or GRE _____

Describe your parents' attitude toward mathematics during your childhood:

Very negative _____ Negative _____ Uncertain _____

Positive _____ Very Positive _____

Parent's educational background:

Mother:

Below high school graduation _____

High school graduation _____

2-year college graduation _____

4-year college graduation _____

Graduate school graduation _____

Father:

Below high school graduation _____

High school graduation _____

2-year college graduation _____

4-year college graduation _____

Graduate school graduation _____

What was your level of mathematics achievement?

High (above 90%) _____ Above average (80%-90%) _____ Average (70%-80%) _____

Below average (50%-70%) _____ Low (below 50%) _____

APPENDIX G
OBSERVATION FORM

Coding	Date: Time:	Setting:	University Supervisor:	Teacher Candidate:
	Observations		Reflections	

APPENDIX H
SEMI-STRUCTURED INTERVIEW QUESTIONS – UNIVERSITY
SUPERVISORS

BUILD RAPPORT

1. Tell me about your background in education. (i.e. certification, math courses, favorite subject to teach)
2. What led you to supervise teacher candidates?
 - a. Why do you want to work with teacher candidates?
3. Tell me about your position as a university supervisor.

BACKGROUND

4. How did you prepare yourself for this role (university supervisor)?
5. What do you need to know and be able to do to assist teacher candidates (Three key areas/ things)?

RQ 1: What are the effects of training university supervisors on mathematics education coaching practices on teacher candidates' beliefs and teaching in mathematics?

6. Talk about teacher candidates' instruction in mathematics since the training.
 - a. How has the instructional practice changed since the professional development?
 - b. What are the things that you focus on now?

7. How do you see the teacher candidates' assignments for mathematics methods matching with the cooperating teachers' instruction in the field?

(DISCONNECT/ COHERENCE)

- a. How do you provide support to bridge the two?
8. What advice or insight would you like to share with the mathematics methods instructors?

RQ 2: What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?

9. Talk about the kind of support you give to teacher candidates in mathematics.
10. How has that changed since the professional development?
11. How do you support teacher candidates with the observation cycle (pre-conference, observation, and post conference)?
12. What do you look for in a mathematics lesson? Has this changed?
13. How do you handle content errors in mathematics?
14. Describe the support you receive from the university? **(DISCONNECT/ COHERANCE)**
- a. Describe the support you receive from the placement schools?
- b. How would you classify those relationships?
15. What support or training do you wish the university would offer to university supervisors?

BELIEF SYSTEM

16. Which content area is the most difficult to help a teacher candidate understand or work with? Why do you think this is so?

17. How would you describe your teaching of mathematics?
18. What do you think is important for elementary students to understand in the content area of mathematics?
19. On a scale of 1-10 (1 easy, 10 difficult), how would you describe your work with teacher candidates in the content areas (literacy, math, social studies, science)?

CLOSING

20. Is there anything that I didn't ask about that you would like to add?

Questions inspired by Pelletier, C. M. (2000). A handbook of techniques and strategies for coaching student teachers (2nd ed.). Needham Heights, MA: Allyn & Bacon.

APPENDIX I
SEMI-STRUCTURED INTERVIEW – TEACHER CANDIDATES

BUILDING RAPPORT

1. Tell me a little about yourself and how your program is going so far.
2. Describe yourself as a student learning mathematics.
3. Describe your experience in mathematics methods.
 - a. What were the highlights?
 - b. Struggles?
4. Who were your strongest models? Mentors?

RQ 1: What are the effects of training university supervisors on mathematics education coaching practices on teacher candidates' instruction in mathematics?

5. Who provided the most support in helping you with mathematics lessons?
 - a. How did the teaching go? Were there any problems?
 - b. Who provided the support for you? What kind of feedback did you get from your cooperating teacher and university supervisor?
 - c. How did your mathematics instructor view your work?
 - d. How was your lesson viewed by your instructor?
6. How did analyzing your partner's lesson help you with understanding the teaching of mathematics? (UG only)
7. What do you wish you would have learned in mathematics &/or mathematics education?

RQ 2: What are the effects of training university supervisors in mathematics pedagogy and coaching practices on their supervision practices in observing mathematics lessons of teacher candidates?

8. Describe the support or supervision provided to you by the university supervisor.
9. What were the most beneficial supports provided to you?
10. What did he/ she help you understand or improve with your teaching of mathematics?
11. Did you need mathematics support that you didn't get?

ATTEMPTING TO ADDRESS CONFOUNDERS (IF NEEDED)

12. Who were the pivotal people in helping you understand and teach elementary mathematics? Explain.
 - a. Can you give examples?
 - b. Describe the impact of your cooperating teacher on your mathematics teaching.
 - c. Describe the impact of you university supervisor on your mathematics teaching.
 - d. Describe the impact of you mathematics instructor on your mathematics teaching.

BELIEFS

13. How did your attitudes about the teaching and learning of mathematics change during the semester? Explain.
 - a. What do you think can be attributed to the change?

CLOSING

14. Is there anything that I didn't ask about that you would like to add?

APPENDIX J REFLECTION

What was something from the professional development that **pushed** your thinking?

What is something that you will **commit** to using in your role as university supervisor?

What is something that you still **question**?

What **support** do you need in order to move forward in using the ideas from the professional development?

Other **thoughts**?

APPENDIX K
GOAL SETTING TEMPLATE

Goal	Progress	Progress
1.		
2.		
3.		

APPENDIX L
CONTACT SUMMARY SHEET

Contact	Date	Time	Main themes	Issues/ Problems	Questions that arose

APPENDIX M
DOCUMENT SUMMARY SHEET

Name of Document	Event or Contact Involved	Significance	Summary of Contents

APPENDIX N
COACHING CODES AND POST-OBSERVATION FORM

Categories

Open- Ended (OE)

Mediative (M)

Closed (C)

Probing (P)

Content specific (CS)

Behavioral or Performance Specific (B)

Lesson Planning (LP)

Post-Conference

APPENDIX O

START LIST OF CODES

Code	Theme	Reference
AX	Anxiety	Kolstand & Hughes, 1994
NTR CPTS	Interrelated Concepts	Ambrose et al. 2004
PR NU	Know procedure; don't understand	Ambrose et al. 2004
PWR	Understanding is powerful	Ambrose et al. 2004
CPTS B4 PR	Concepts before procedures	Ambrose et al. 2004
FLEX	Flexibility	Ambrose et al. 2004
RW	Real world contexts	Ambrose et al. 2004
TNK	Student thinking	Ambrose et al. 2004
NRW	Math isn't related to real world	Ball, 1988
PR	Procedural focus	Ball, 1988
TL	Teaching involves telling	Ball, 1988
? RA	Questioning for right answer	Ball, 1988
SCRY	Math is scary	Ball, 1988
FUN	Good teachers make it fun	Ball, 1988
ELM ↓ KN	Elementary teachers don't need as much content knowledge	Ball, 1988
♡ Kids	Love of kids more important than content knowledge	Ball, 1988
N THK	Young children aren't capable of thinking	Ball, 1988

APPENDIX P

BASELINE RESPONSE TO THE MBI

MBI Part A	Agree	Disagree	No Response
1. Problem solving should be a separate, distinct part of the mathematics curriculum.	6TC	10TC 3 US	2TC
2. Students should share their problem-solving thinking and approaches with other students.	18TC 3US		
3. Mathematics can be thought of as a language that must be meaningful if students are to communicate and apply mathematics productively.	18TC 3US		
4. A major goal of mathematics instruction is to help children develop the belief that they have the power to control their own success in mathematics.	18TC 3US		
5. Children should be encouraged to justify their solutions, thinking, and conjectures in a single way.	5TC 1US	13TC 2US	
6. The study of mathematics should include opportunities of using mathematics in other curriculum areas.	18TC 3US		
7. The mathematics curriculum consists of several discrete strands such as computation, geometry, and measurement which can best be taught in isolation.	5 TC	12TC 3US	1TC
8. In K-5 mathematics, increased emphasis should be given to reading and writing numbers symbolically.	10TC 1US	6TC 1US	2TC 1US
9. In K-5 mathematics, increased emphasis should be given to use of clue words (key words) to determine which operation to use in problem solving.	1TC 2US	17TC 1US	
10. In K-5 mathematics, skill in computation should precede word problems.	5TC	13TC 3US	

11. Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragments as a result of repeated practice and reinforcement.	11TC 1US	7TC 2US	
12. Mathematics should be taught as a collection of concepts, skills and algorithms.	16TC 2US	2TC 1US	
13. A demonstration of good reasoning should be regarded even more than students' ability to find correct answers.	16TC 3US	1TC	1TC
14. Appropriate calculators should be available to all students at all times.	7TC 2US	10TC 1US	1TC
15. Learning mathematics must be an ACTIVE PROCESS.	18TC 3US		
16. Children enter kindergarten with considerable mathematical experience, a partial understanding of many mathematical concepts, and some important mathematical skills.	14TC 3US	4TC	

Part B & C

	True	More true than false	More false than true	False	No Re-sponse
17. Some people are good at mathematics and some aren't.	1TC	4TC	7TC 2US	5TC 1US	1TC
18. In mathematics something is either right or it is wrong.	1TC	2TC	4TC 1US	10TC 1US	1TC 1US
19. Good mathematics teachers show students lots of different ways to look at the same question.	17TC 3US				1TC
20. Good math teachers show you the exact way to answer the math question you will be tested on.		4TC	4TC 2US	9TC 1US	1TC
21. Everything important about mathematics is already known by mathematicians.	1TC	1TC	3TC	11TC 3US	1TC
22. In mathematics you can be creative and discover things by yourself.	12TC 3US	5TC			1TC
23. Math problems can be done correctly in only one way.	1TC		1TC	15TC 3US	1TC
24. To solve most math problems you have to be taught the correct procedure.	1TC	1US	8TC 1US	8TC 1US	1TC

25. The best way to do well in math is to memorize all the formulas.			16TC 2US	1TC 1US	1TC
26. Males are better at math than females.		3TC	1US	12TC 2US	3TC
27. Some ethnic groups are better at math than others.		4TC	2TC	10TC 3US	2TC
28. To be good in math you must be able to solve problems quickly.		2TC 2US	6TC 1US	9TC	1TC
PART C					
29. I am very good at learning mathematics.	5TC	8TC 2US	2TC 1US	2TC	1TC
30. I think I will be very good at teaching mathematics.	5TC	11TC 3US	1TC		1TC

APPENDIX Q

MATHEMATICS AND COACHING AGENDA DAY ONE

Mathematics & Coaching

AGENDA

Welcome & Paperwork

High Quality Mathematics



Rapport

Paraphrasing

Questioning

RTOP

Setting Goals

APPENDIX R

MATHEMATICS AND COACHING AGENDA DAY TWO

Mathematics & Coaching

AGENDA

Day 2



Review Coaching Strategies: Rapport & Paraphrasing

The Art of Questioning

RTOP

Video

Coach Me

Exit Slip

APPENDIX S
FOLLOW UP PD AGENDA



Agenda

ECEE University Supervisors Meeting
October 14, 2011

- | | |
|-------------|--|
| 9:00-9:30 | Opening: How's it going?
Build the agenda: issues and concerns |
| 9:30-10:00 | KTIP Tasks A 1, A2, B and C- Peggy Brooks |
| 10:00-11:00 | MAT Methods Discussion
Student Teacher Placements
Other spring 2012 methods placements
Orientation Schedule |
| 11:00-12:00 | Coaching Follow Up Stefanie Livers |
| 12:00-12:30 | Networking: invitation to methods instructors |

APPENDIX T

UNIVERSITY SUPERVISORS' RESPONSES TO THE MBI

(*n=11*)

MBI Part A	Agree	Disagree	No Response
1. Problem solving should be a separate, distinct part of the mathematics curriculum.	2 1	9 10	
2. Students should share their problem-solving thinking and approaches with other students.	11 11	0 0	
3. Mathematics can be thought of as a language that must be meaningful if students are to communicate and apply mathematics productively.	11 11	0 0	
4. A major goal of mathematics instruction is to help children develop the belief that they have the power to control their own success in mathematics.	10 11	1 0	
5. Children should be encouraged to justify their solutions, thinking, and conjectures in a single way.	4 2	7 9	
6. The study of mathematics should include opportunities of using mathematics in other curriculum areas.	11 11	0 0	
7. The mathematics curriculum consists of several discrete strands such as computation, geometry, and measurement which can best be taught in isolation.	0 1	9 10	2
8. In K-5 mathematics, increased emphasis should be given to reading and writing numbers symbolically.	5 6	6 4	1
9. In K-5 mathematics, increased emphasis should be given to use of clue words (key words) to determine which operation to use in problem solving.	9 8	2 3	

10. In K-5 mathematics, skill in computation should precede word problems.	2 2	8 9	1
11. Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragments as a result of repeated practice and reinforcement.	3 4	7 6	1 1
12. Mathematics should be taught as a collection of concepts, skills and algorithms.	10 8	1 3	
13. A demonstration of good reasoning should be regarded even more than students' ability to find correct answers.	11 10	0 0	1
14. Appropriate calculators should be available to all students at all times.	6 5	4 6	1
15. Learning mathematics must be an ACTIVE PROCESS.	10 11	0 0	1
16. Children enter kindergarten with considerable mathematical experience, a partial understanding of many mathematical concepts, and some important mathematical skills.	11 9	0 2	

Part B & C

	True	More true than false	More false than true	False	No Response
17. Some people are good at mathematics and some aren't.	3 2	5 1	2 6	1 2	
18. In mathematics something is either right or it is wrong.	1 2	5 2	3 5	2 2	
19. Good mathematics teachers show students lots of different ways to look at the same question.	10 11	1 0	0 0	0 0	
20. Good math teachers show you the exact way to answer the math question you will be tested on.	0 0	2 1	3 3	4 7	2
21. Everything important about mathematics is already known by mathematicians.	0 0	2 3	0 3	9 5	
22. In mathematics you can be creative and discover things by yourself.	8 6	3 4	0 0	0 1	
23. Math problems can be done correctly in	0	0	2	9	

only one way.	0	1	2	8	
24. To solve most math problems you have to be taught the correct procedure.	0	3	3	4	
	0	4	1	5	
25. The best way to do well in math is to memorize all the formulas.	0	1	3	7	
	0	2	3	6	
26. Males are better at math than females.	0	0	2	9	
	0	1	2	8	
27. Some ethnic groups are better at math than others.	0	0	2	9	
	0	0	1	10	
28. To be good in math you must be able to solve problems quickly.	0	0	1	10	
	0	0	2	9	
PART C					
29. I am very good at learning mathematics.	2	6	2	1	
	2	5	2	2	
30. I think I will be very good at teaching mathematics.	4	5	0	2	
	3	6	1	1	

APPENDIX U

TEACHER CANDIDATES' RESPONSES TO THE MBI

(n=78)

MBI Part A	Agree	Disagree	No Response
1. Problem solving should be a separate, distinct part of the mathematics curriculum.	37 12	40 66	
2. Students should share their problem-solving thinking and approaches with other students.	77 78	1 0	
3. Mathematics can be thought of as a language that must be meaningful if students are to communicate and apply mathematics productively.	75 78	2 0	1
4. A major goal of mathematics instruction is to help children develop the belief that they have the power to control their own success in mathematics.	71 75	5 2	2 1
5. Children should be encouraged to justify their solutions, thinking, and conjectures in a single way.	66 4	12 74	
6. The study of mathematics should include opportunities of using mathematics in other curriculum areas.	76 77	1 1	1
7. The mathematics curriculum consists of several discrete strands such as computation, geometry, and measurement which can best be taught in isolation.	15 6	62 72	1
8. In K-5 mathematics, increased emphasis should be given to reading and writing numbers symbolically.	53 46	25 30	2
9. In K-5 mathematics, increased emphasis should be given to use of clue words (key words) to determine which operation to use in problem solving.	74 33	4 44	1

10. In K-5 mathematics, skill in computation should precede word problems.	51 28	25 50	2
11. Learning mathematics is a process in which students absorb information, storing it in easily retrievable fragments as a result of repeated practice and reinforcement.	64 50	14 26	2
12. Mathematics should be taught as a collection of concepts, skills and algorithms.	74 68	4 10	
13. A demonstration of good reasoning should be regarded even more than students' ability to find correct answers.	66 73	12 5	
14. Appropriate calculators should be available to all students at all times.	27 17	51 60	1
15. Learning mathematics must be an ACTIVE PROCESS.	78 77	0 0	1
16. Children enter kindergarten with considerable mathematical experience, a partial understanding of many mathematical concepts, and some important mathematical skills.	24 26	53 52	1

Part B & C

	True	More true than false	More false than true	False	No Re-sponse
17. Some people are good at mathematics and some aren't.	21 6	32 19	12 20	12 33	
18. In mathematics something is either right or it is wrong.	14 3	35 28	14 23	14 24	
19. Good mathematics teachers show students lots of different ways to look at the same question.	65 74	12 4	1 0	0 0	
20. Good math teachers show you the exact way to answer the math question you will be tested on.	12 2	17 6	24 25	25 45	
21. Everything important about mathematics is already known by mathematicians.	4 0	2 6	17 19	55 53	
22. In mathematics you can be creative and discover things by yourself.	43 60	20 14	13 3	2 0	
23. Math problems can be done correctly in	0	2	22	54	

only one way.	1	0	11	66	
24. To solve most math problems you have to be taught the correct procedure.	24 7	36 22	8 28	10 20	1
25. The best way to do well in math is to memorize all the formulas.	3 1	22 2	23 21	30 54	1
26. Males are better at math than females.	1 2	11 9	7 5	58 62	1
27. Some ethnic groups are better at math than others.	4 2	21 12	6 10	46 54	1
28. To be good in math you must be able to solve problems quickly.	0 0	13 7	21 21	43 50	1
PART C					
29. I am very good at learning mathematics.	15 29	39 34	15 13	8 2	1
30. I think I will be very good at teaching mathematics.	20 33	49 42	6 2	2 1	1

CURRICULUM VITAE

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ACADEMIC BACKGROUND

- 2012 Doctorate of Philosophy** **UNIVERSITY OF LOUISVILLE**, Louisville, KY
Curriculum & Instruction: Mathematics Education
Advisor: Karen Karp
Dissertation: Coaching the Coaches: Supporting
University Supervisors in the Supervision of
Elementary Mathematics Instruction
- 1997 Masters in Teaching** **UNIVERSITY OF LOUISVILLE**, Louisville, KY
Early Childhood Education K-5
- 1994 Bachelor of Arts** **UNIVERSITY OF LOUISVILLE**, Louisville, KY
Major: Psychology Minor: Sociology

PROFESSIONAL EXPERIENCE

UNIVERSITY OF LOUISVILLE, Louisville, KY
August 2009- current **Instructor- Full**
Time
Courses:
Elementary Mathematics Methods
The Teaching Profession
Building Learning Communities
Promoting Student Learning in K-12 Classroom
Curriculum Theory
Teacher Leader: Mentoring and Coaching
Literacy Learning and Cultural Differences

Department and College Committees:

Masters Redesign

Honors and Awards

Honors and Scholarship

Department Projects:

Gifted and Talented Program Review Document (with G. Shack & N. Beck)

Elementary Mathematics Specialist Program Review Document

SHELBY COUNTY PUBLIC SCHOOLS, Shelbyville, KY

July 2006 – August 2009

Student Achievement Consultant

Mentor teachers; model mathematics lessons; conduct school & district professional development; analyze data; write grants, assist in curriculum and instruction decisions at school & district level; align district and school curriculum; conduct walk throughs; provide expertise in mathematics instruction

UNIVERSITY OF LOUISVILLE, Louisville, KY

January 2006-August 2009

Adjunct Instructor – Part Time

Courses Taught:

Elementary Mathematics Methods

Introduction to Teaching Elementary Mathematics

Teacher Leadership: Mentoring and Coaching

Promoting Student Learning in K-12 Classroom

GOSHEN ELEMENTARY, Prospect, KY

June 2001- July 2006

Elementary School Teacher

Taught third/fourth grade multi-age; Writing Cluster Leader; Site Based Decision Making (SBDM) council member; Budget committee; Science Club sponsor; Kentucky Teacher Intern Program (KTIP) Mentor

BARDSTOWN ELEMENTARY, Bardstown, KY

July 1998- June 2001

Elementary School Teacher

Taught third/fourth grade multi-age, self-contained fourth grade; taught first and second grade sessions of ESS; founded the first science club; Site Based Decision Making (SBDM) council member

THE DePAUL SCHOOL, Louisville, KY

Sept. 1997-June 1998

Elementary School Teacher

Taught third grade; planned units and lessons to meet the needs of dyslexic students

HONORS AND AWARDS

2011/2001	National Board Certified Teacher
2010	Inducted into Pi Lambda Theta
2008	Inducted into Golden Key International Honor Society
2006	State Finalist for Presidential Award for Excellence in Mathematics Teaching (Elementary)
2005	Oldham County Teacher of Excellence Academy
2003	Louisville Writing Project Fellow
2001	Distinguished member Commonwealth Institute for Teachers
2000	Kentucky Reading Project Fellow

CERTIFICATIONS

Levels of Teaching Innovation (LoTi) National Mentor Certification	2007
National Business Education Alliance	
Elementary Education Program Consultant	2006
National Board Certification Middle Childhood Generalist	2001
Teaching in Early Elementary Grades K-4 (and Self Contained Grades 5-6)	1997

PUBLICATIONS

Curriculum Materials

Thompson, C., Bush, W. Beswick, G., Chady, A., Jewell, L., **Livers, S.**, Nussbaum, S. and Scott, O. (2008). *Math Matters* (lessons for tutoring K-3 students in mathematics) Lexington, KY: Partnership for Successful Schools.

Referred Journal Articles

Bay-Williams, J. & Livers, S. (2009). Making Decisions about Vocabulary Support in Mathematics Teaching. *Teaching Children Mathematics*, 16(4), 238 – 245.

PRESENTATIONS

National Conferences

Culture, Language, and Teaching: Three Dimensions to Supporting ELLs. Co-presenter (with J. Bay-Williams) at The National Council of Teachers of Mathematics Annual Conference, 2011, Indianapolis, Indiana.

Effective Communication Among PDS Participants. Round table speaker (with C. Thompson and fellow MAT students) at The Professional Development School Conference, 1997, Louisville, Kentucky.

State and Local Conferences

Critical friends: Building a Professional Learning Community. Poster session at Ideas to Action (i2a) Institute: Developing Critical Thinkers, 2011, University of Louisville, Louisville, Kentucky.

Diagnostic Interviews. Roundtable speaker at The STEM Commonwealth Institute for Parent Leadership supported by Prichard Committee for Academic Excellence, 2009, Louisville, Kentucky.

High Quality Mathematics Instruction: Reaching Every Child, Every Day.

Presentation given (with R. Metzger) at Kentucky Teaching and Learning Conference, 2008, Louisville, Kentucky.

A Journey to Proficiency –The 21st Century Skills. Presentation given (with S. Whitt, R.Dow & M. Young) at Kentucky Teaching and Learning Conference, 2008, Louisville, Kentucky.

Road to Reflection: Looking Back Through the Lens of Literacy. Presentation given (with S. Whitt & J. Penix) at Kentucky Teaching and Learning Conference, 2008, Louisville, Kentucky.

Stimulating Neural Pathways. Presentation given at Louisville Writing Project Mini-Conference, 2004, Louisville, Kentucky.

Journey to Reading Proficiency Strategies to Boost Your Reading Workshop. Presentation given (with S. Whitt) at Kentucky Teaching and Learning Conference, 2004, Louisville, Kentucky.

Communication with Families. Presentation given (V. Miller-Bennett) at Kentucky Association for National Board Certified Teachers Conference, 2004, Bowling Green.

Stimulating Neural Pathways. Presentation given at Kentucky Teaching and Learning Conference, 2003, Louisville, Kentucky.

Journey to Reading Proficiency Strategies to Boost Your Reading Workshop.

Presentation given (with S. Whitt) at Kentucky Teaching and Learning Conference, 2003, Louisville, Kentucky.

The Road Less Traveled. Presentation given at Kentucky Teaching and Learning Conference, 2002, Louisville, Kentucky

I'm In Charge of Celebrations. Presentation given at Kentucky Reading Association Conference, 2001, Louisville, Kentucky.

Invited Local Presentations and Workshops

High Quality Mathematics Instruction. Presentation given (with R. Metzger) for Straub Elementary, 2008, Maysville, KY.

Cognitive Coaching. Presentation given for Jefferson County Public School ELL Teacher Mentors in collaboration with the University of Louisville, 2008, Louisville, Kentucky.

Geometry. Presentation given for Shelby County Public Schools, 2008, Shelbyville, Kentucky.

Data Analysis & Probability. Presentation given for Shelby County Public Schools, 2008, Shelbyville, Kentucky.

Numbers & Computation. Presentation given for Shelby County Public Schools, 2008, Shelbyville, Kentucky.

High Quality Mathematics Instruction: Understanding Your Mathematics Program. Presentation given (with R. Metzger & K. Hauber) for Shelby County Public Schools, 2008, Shelbyville, Kentucky.

Conscious Discipline. Presentation given for Wright Elementary, 2007-2008, Shelbyville, Kentucky.

Differentiation. Presentation given for Wright Elementary, 2007, Shelbyville, Kentucky.

High Quality Math Instruction: Understanding Your Math Program.

Presentation given (with R. Metzger & K. Hauber) for Shelby County

Public Schools, 2007, Shelbyville, Kentucky.

High Quality Mathematics Instruction for Principals. Presentation given (with M. Nicholson) for Shelby County Public Schools, 2007, Shelbyville, Kentucky.

Cognitive Coaching. Presentation given for Shelby County Public Schools, 2006 -2007, Shelbyville, Kentucky.

Math the Goshen Way. Presentation given (with V. Miller-Bennett) for parents at Goshen Elementary, 2004, Prospect, Kentucky.

Reading and Writing with the Brain in Mind. Presentation for Goshen Elementary, 2003, Prospect, Kentucky.

Reading and Writing with Brain Research. Presentation given for Longest Elementary, 2004, Greenville, Kentucky.

Reading and Writing. Presentation given (with V. Miller -Bennett) for New Castle Elementary, 2003, New Castle, Kentucky.

SERVICE

National Service

Association for Supervision and Curriculum Development	Member 2009- present
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National Board for Professional Teaching Standards	2002
Service Activity: Teaching America About Accomplished Teaching	

National Council Teachers of Mathematics	member 1997 - present
Service Activity: Manuscript Reviewer	

National Science Teachers Association	member 1997- 2009
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State Service

Greater Louisville Council of Teachers of Mathematics	Member 2007-present
Kentucky Association of National Board Certified Teachers	Regional representative 2002 - 2008

Kentucky Council of Teachers of Mathematics

Member 2006-present

GRANTS

Critical Friends: Building a Professional Learning Community. (2009). Ideas to Action (i2a) Sun Grant. \$ \$2370.08

Super Scientist. (2000). Bardstown Foundation for Excellence. \$500

Super Scientist. (1999). Bardstown Foundation for Excellence. \$500